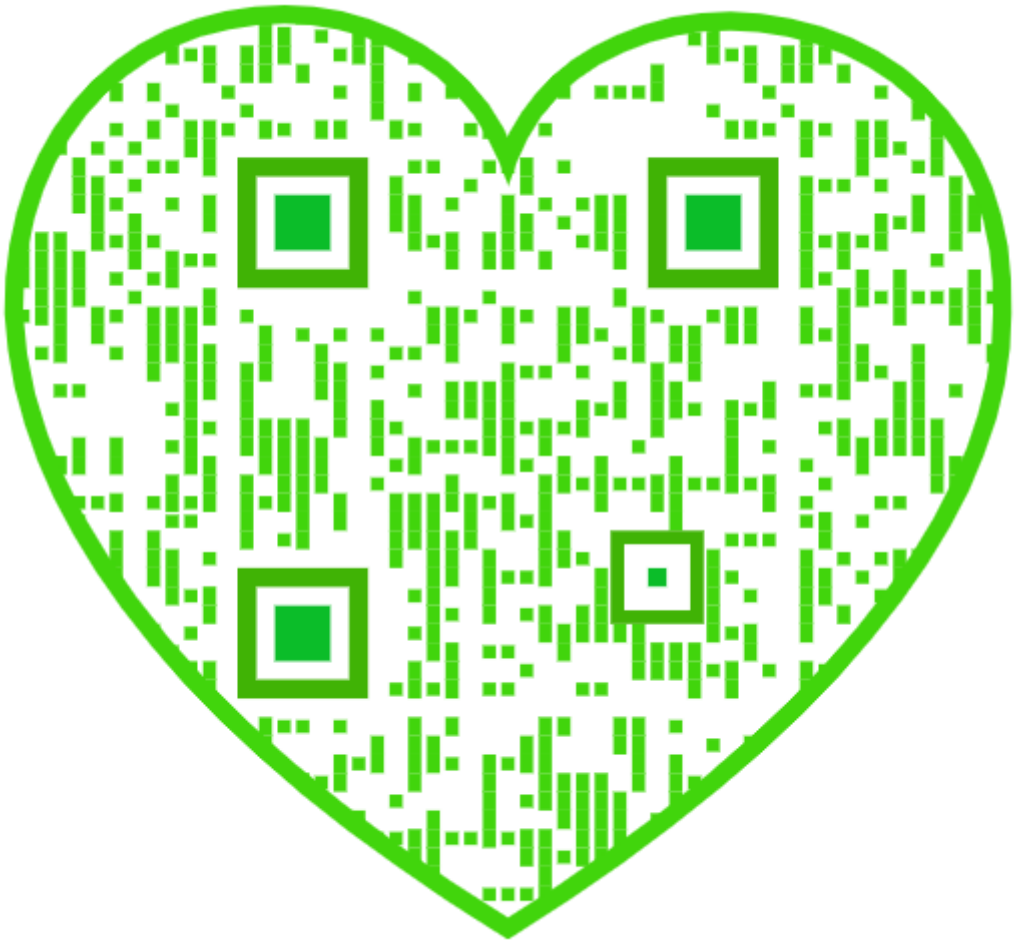
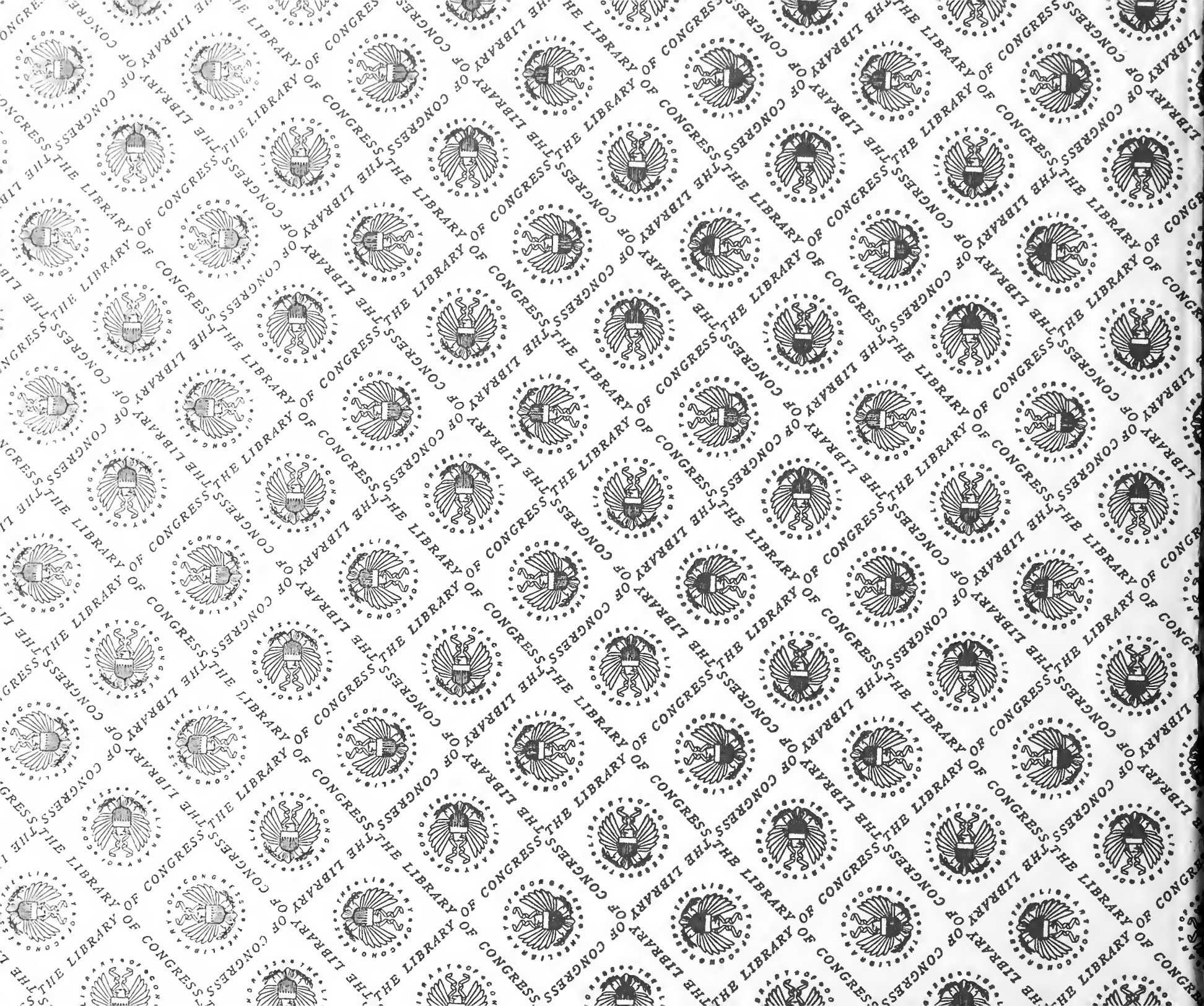
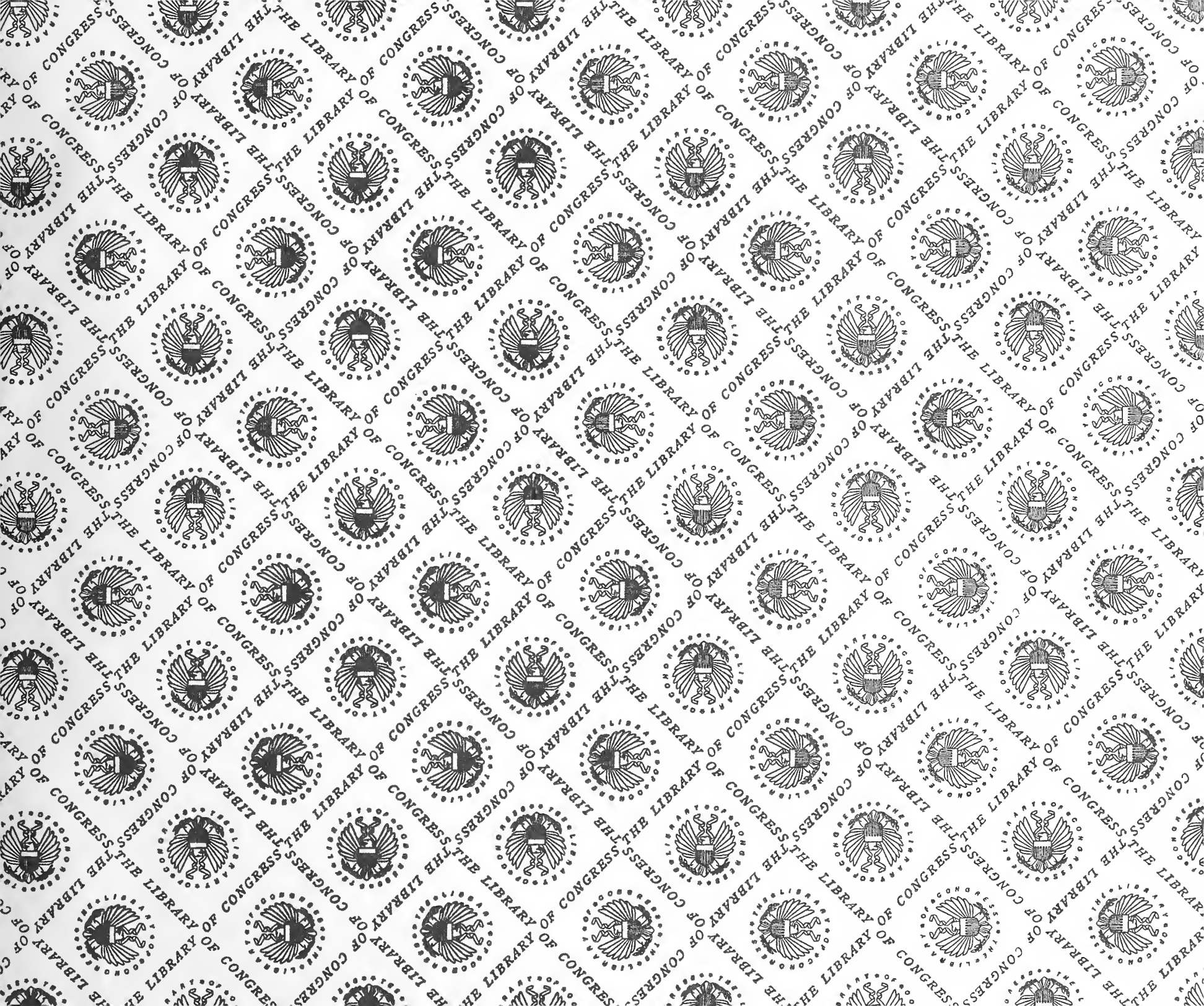



THE LIBRARY OF CONGRESS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JOSEPH H. WALLACE & CO.

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INDUSTRIAL ENGINEERS.

NEW YORK. LONDON.

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FOREWORD

THIS volume is issued to further our acquaintance with industrial interests. Manufacturers of to-day believe in consultation with practical engineers familiar with problems general to industrial developments, and bankers and investors in industrial securities want unbiased reports and appraisals of properties in which they are or may become interested.

Joseph H. Wallace & Company have been organized especially to meet this demand and undertake only industrial engineering work, covering questions of hydraulics, steam, electricity, structural and mill building, consultation, appraisals and reports on condition of manufacturing and power plants.

A department of tests has recently been organized, and undertakes complete tests of steam and hydraulic power plants.

We attempt to present only a few representative recent installations selected from upwards of fifty pulp, paper and power plants, the engineering for which has been entirely done by members of our own organization. Special engineering services have been furnished for many other important installations where the owners had their own engineering staff.

THE INDUSTRIAL ENGINEER IN THE MILL

Engineering has been defined as, "The art of directing the great sources of power in nature for the use and benefit of man."

The pioneers of the profession command our respect: having little specific knowledge on which to base their calculations, no systematic compilation of facts, and but an imperfect understanding of the fundamental laws of nature, nevertheless, they built aqueducts, canals, bridges and sewers, regulated river flow and protected the lowlands from the sea's encroachments.

Telford thus answered a young man who asked advice about studying for the practice of engineering, "I have built all the roads and made all the canals and harbors. I don't see what there is that you expect to do." Yet, Telford was from 1800-1825 at the head of his profession and the first president of the Institute of Civil Engineers (1820).

Developments in physics, chemistry and philosophy during the century just passed have proportionately broadened the work of the engineer, who must keep himself informed of the progress in all branches of natural science, in order to secure such new materials or new forms of energy, as may be applied to practical use. Likewise, the fuller knowledge of the properties and the action of matter has induced investigation of the means possible to resist or eliminate disturbing forces.

In reviewing scientific development, one cannot fail to be struck by the tremendous acceleration in the rate of progress. Even as the 19th Century eclipsed all the past in engineering expansion, so its last quarter surpassed the first three. When the American Society of Civil Engineers was founded in 1852, it had become evident that engineering was not a specialty, but the general application of the work of all scientists. Still, as late as 1875, the practicing engineer, while called on to direct work of great magnitude, was expected to have an intimate and detailed knowledge of all branches. With equal facility he built and equipped railways, canals, manufacturing and power plants, or systems of waterworks or sewers; and his ability in one field was accepted as evidence of his skill in all.

During the practice of even our younger engineers, the accumulation of scientific data, facts, and formulæ has been too rapid to permit any individual to accurately acquire more than the knowledge and experience necessary in a limited branch of engineering. The profession has, therefore, become subdivided, until the modern engineering organizations are composed of specialists in each branch.

It is the engineer's province to so direct the applications of energy as to bring about progress and economy of operation. In a proposed work he must have a due regard to the "period of probable usefulness," for time and progress will make antiquated the most marvelous work of his age, and "erecting monuments" only develops criticism.

In no branch of the engineering profession is this consideration—"period of probable usefulness"— a

greater factor than in *Industrial Engineering*, by which term is meant that specialization of practice involved in the design and erection of manufacturing and power plants.

An organization to undertake industrial work should be familiar with the problems common to industrial plants generally; such as, mechanical handling of materials; devices for labor saving and for protection against fire and accident; generation and distribution of power, whether hydraulic, steam, gas, or electrical; practical uses of the various building materials; as well as a knowledge of the usual methods of manufacturing, and particularly those concerned in the specialized line.

Mill engineers have come into prominence because of their experience in plants for special products, such as steel, cotton or cement.

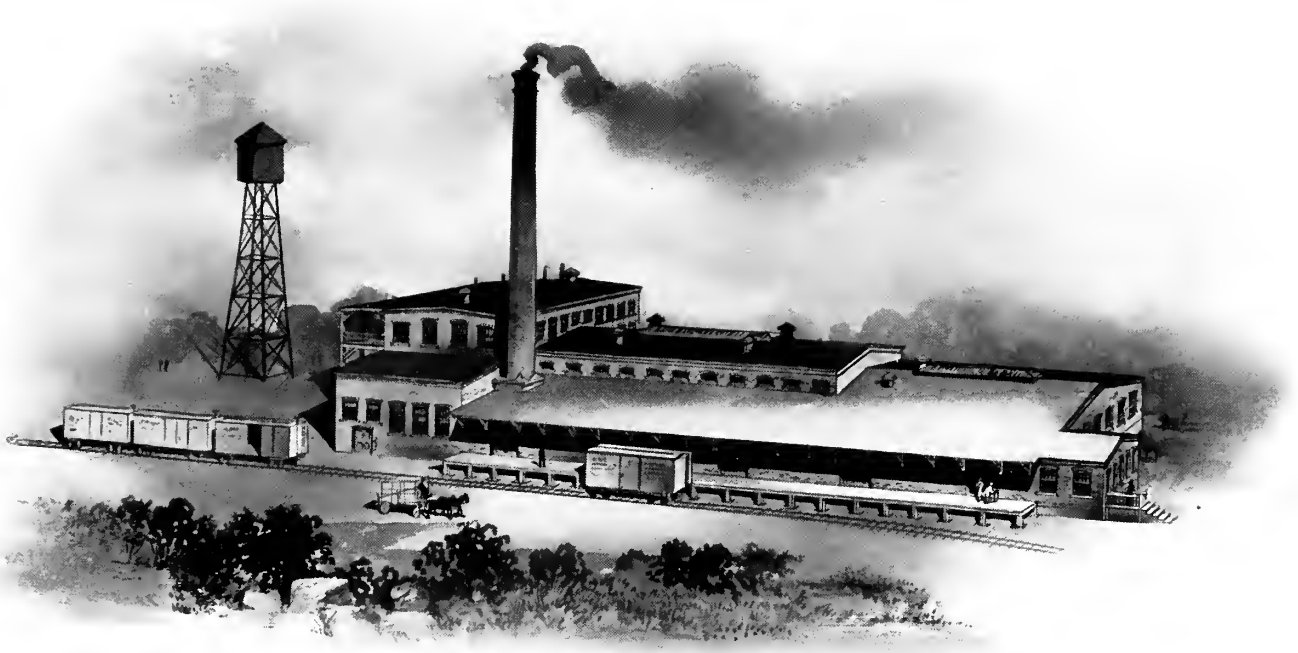
The history of paper mill engineering in America is largely the story of the work of the "Towers of Holyoke," followed by the younger generation of engineers trained in the Tower offices. Holyoke, "the paper city," was largely built by the Tower Brothers, and more recently a number of the noteworthy pulp and paper mills erected in America have been entrusted to "Tower" graduates.

The experience of the members of our organization in paper and pulp mill engineering dates from the early nineties, when Messrs. Wallace and Bowker entered the employ of D. H. and A. B. Tower, and continues through the work of A. B. Tower & Company, Tower & Wallace and J. H. Wallace. In 1901, by associating with Sheaff & Jaastad, the present organization was developed from both concerns, specializing on work relating to plants for "Pulp, Paper and Power." Our work has recently included extensive foreign developments and led to the establishment of an office in London, England. The economic advantage to the client, of our acquaintance with European methods resulting from our visits to many of the important plants of England, Germany, France, Sweden and Norway, is self-evident.

The manufacturer who knows what he wants to build is offered the assistance of an organization trained in the problems that have developed with the growth of this special field, and can have the benefit of our familiarity with what has been done by others in similar lines, and under similar conditions, both in this country and abroad.

REPRESENTATIVE INDUSTRIAL PLANTS

PAGE	OWNERS	LOCATION	PRODUCT
7	Flintkote Mfg. Co.	Arlington, N. J.	Flintkote Roofing Felt.
8	Wall Paper Mfrs., Ltd.	Greenhithe, Kent, England	Esparto Pulp, Newspaper, Wall Papers.
42	Spanish River Pulp & Paper Co., Ltd.	Espanola, Ontario, Canada	Ground Wood Pulp.
56	M. J. Whittall	Worcester, Mass.	Carpets (Power only).
62	Ashuelot Paper Co.	Hinsdale, New Hampshire,	Stock and Copying Tissues.
66	Roanoke Rapids Power Co.	Roanoke Rapids, N. C.	Hydro-Electric Power.
72	Munising Paper Co., Ltd.	Munising, Michigan	Sulphite Pulp, High-Grade Fibre Papers and Specialties.
86	Cambridge Electric Light Co.	Cambridge, Mass.	Light and Power.
93	Quincy Electric Light & Power Co.	Quincy, Mass.	Light and Power.
98	Roanoke Rapids Paper Mfg. Co.	Roanoke Rapids, N. C.	Ground Wood Pulp, Sulphate Pulp, "Kraft" and Wrapping Papers.
108	B. D. Rising Paper Co.	Housatonic, Mass.	Bond and Ledger Papers, Wedding and Index Bristols.
114	American Strawboard Co. (Uncas Plant)	Norwich, Conn.	Newsboard.
116	Rochester, Syracuse & Eastern Ry.	Lyons, N. Y.	Electric Railway Power.
122	Fletcher Paper Co.	Alpena, Michigan	Ground Wood Pulp, Sulphite Pulp, Bag and Manila Papers.
130	J. & J. Rogers Co.	Ausable Forks, N. Y.	Ground Wood Pulp, Sulphite Pulp, Envelope and Wrapping Papers.
138	Kalamazoo Paper Co.	Kalamazoo, Michigan	Book and Writing Papers.



FLINTKOTE MFG. CO., RUTHERFORD, N. J.

The special features of this plant are in the nature of secret methods of manufacture of roofing felt.
We are therefore unable to show more than an exterior view of the buildings
in which "Flintkote" roofing is made.

INGRESS ABBEY MILLS OF THE WALL PAPER MANUFACTURERS, LTD.

POTTER & CO. BRANCH, GREENHITHE, KENT, ENGLAND.

Located on the River Thames, seventeen miles below London, the new Ingress Abbey Mills present many features of interest, not only to the paper trade generally, but to the engineering profession as well. The plant is designed to produce economically a wide variety of papers, and in so doing to utilize all of the available raw materials.

The plant has been developed from the best American practice, modified to take advantage of many European methods of value. In this connection the aid of the company's officials and staff has been of greatest service to the engineers.

The docking facilities for deep water shipment are especially advantageous, and a private siding connects the Southeastern & Chatham Railway with the mill, so that shipments may be received or sent by either rail or water.

Referring to the general plan and perspective, a fair idea of the magnitude of this plant may be had. On the plan the full lines denote the buildings that have been erected for the present installation, the dotted lines, buildings necessary to provide for future extensions.

The arrangement of this plant reduces the handling of raw materials to a minimum and attention has been paid to cleanliness of product, a factor of great importance in the European trade, particularly in the grades manufactured by the company—high-grade decorative papers.

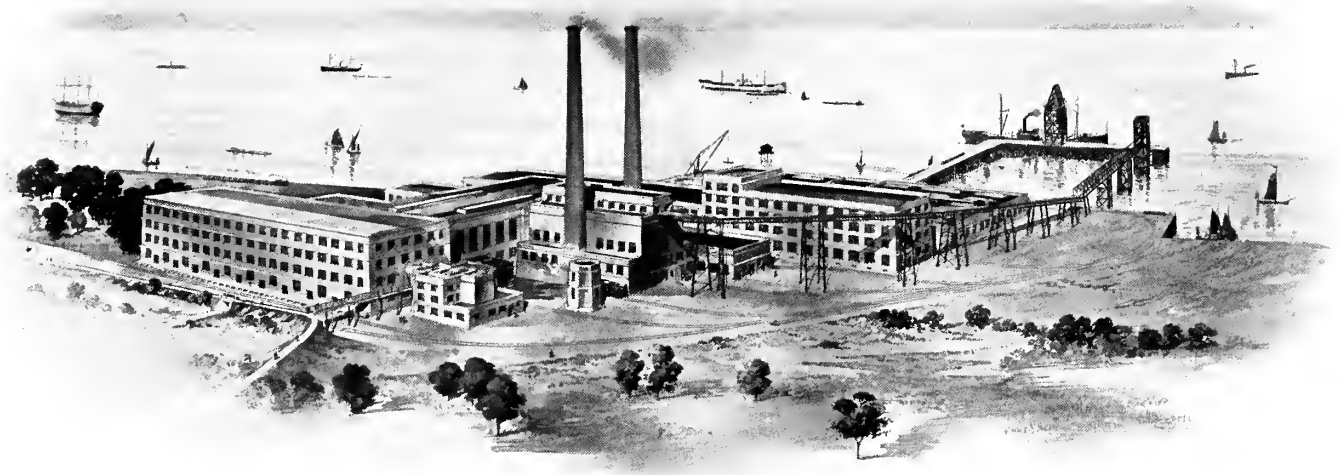
Messrs. Wm. B. Bryan, M. Inst. C. E., Chief Engineer of Metropolitan Water Board, London, and B. W. Bryan, C. E., were retained as consulting engineers in connection with the water supply because of their experience in the handling of the underground water supplies of vicinity of London.

The personal comforts of the employees have also received especial attention, the Company having built a number of model cottages for their work people. Besides the cottages, a well-appointed kitchen and two dining rooms have been arranged. There are also recreation grounds and gardens.

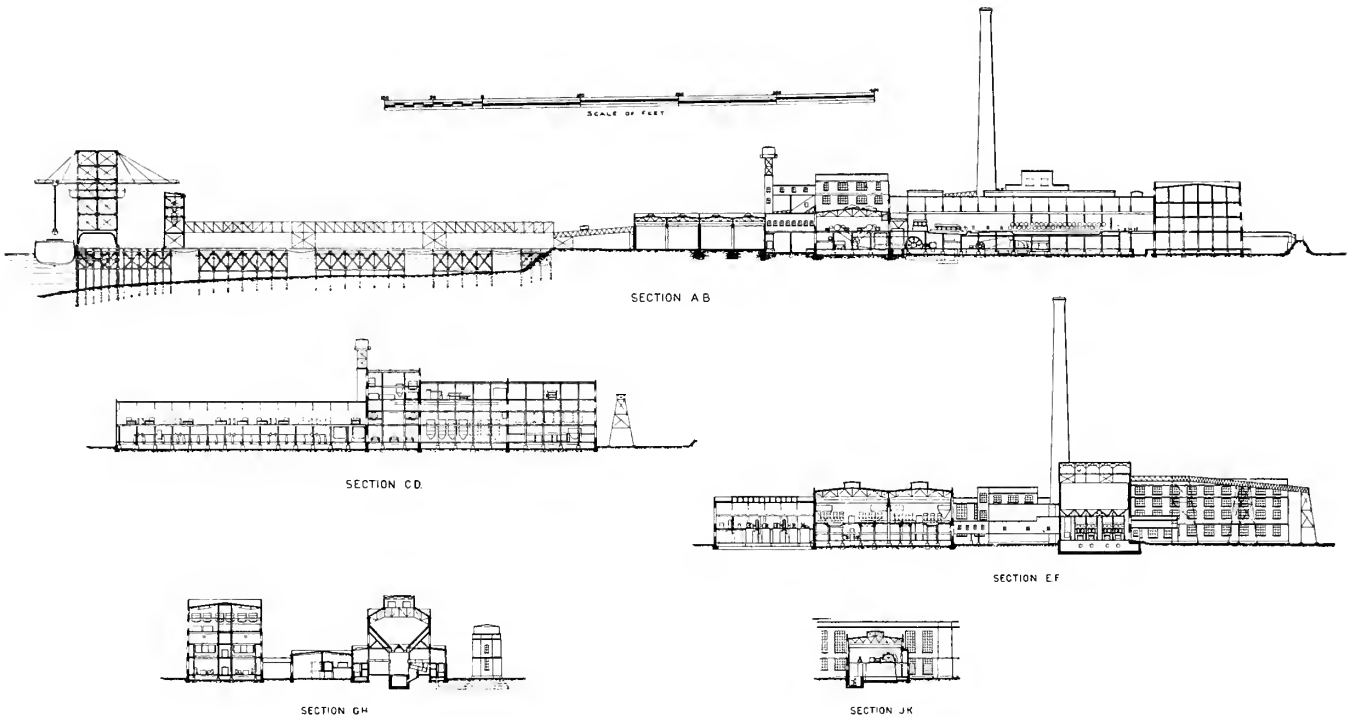
Water Supply.—The natural formation of the ground in the south of England is that of immense chalk deposits, which, sponge-like, carry enormous quantities of clear water within easy pumping distance from the surface of the ground.

Surveys and borings were made and a suitable spot for a Pumping Station was found about 1¼ miles inland from the mill. A well, 14′ 0″ in diameter was sunk through the chalk to a depth of about 75′ 0″ below ground level. From the surface of the ground down to within 4′ 6″ above the rest level of the water in the chalk, the sides of the well are lined with brickwork, the remaining 31′ 0″ to the bottom of the well being lined with cast iron rings, thus forming a cast iron cylinder.

22′ 0″ from the bottom of the well is a cast iron floor, constituting a water-tight bulkhead on which

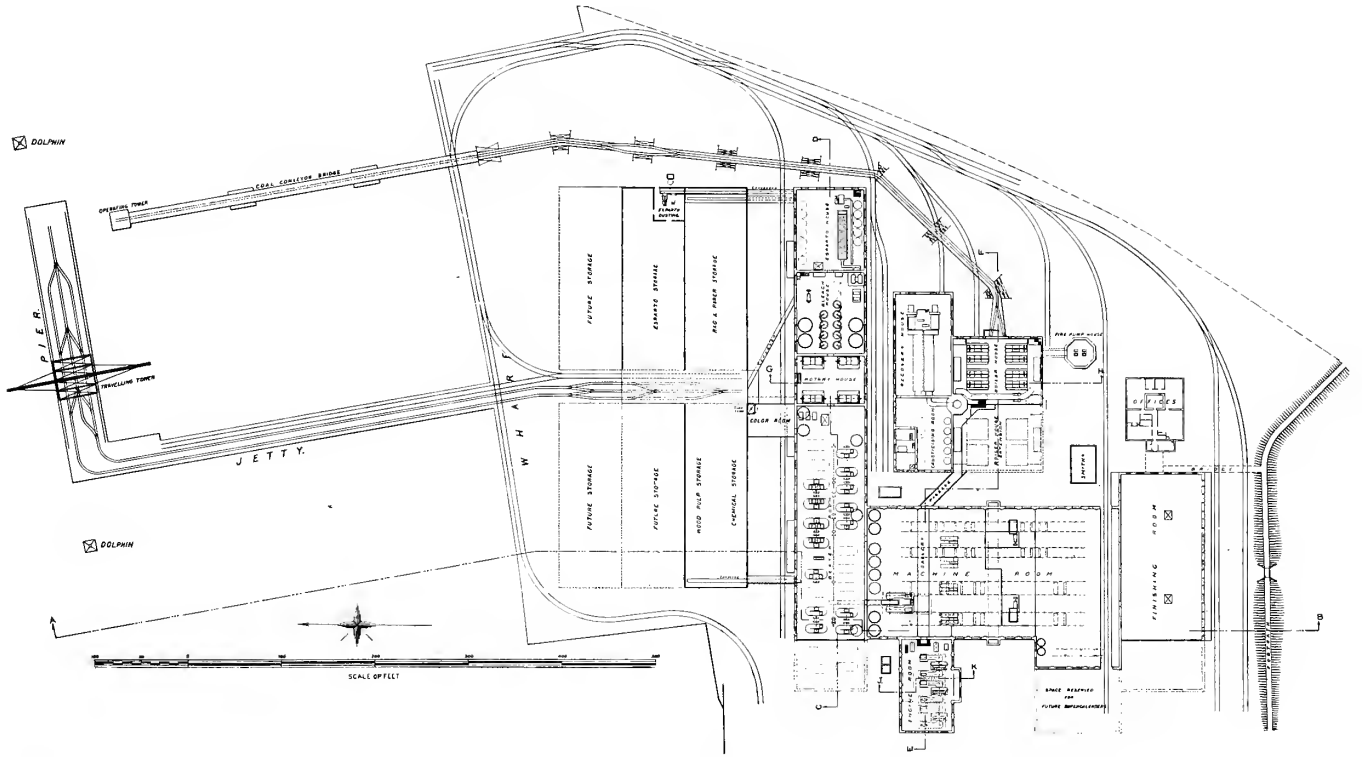


INGRESS ABBEY MILLS, WALL PAPER MANUFACTURERS, LTD., GREENHITHE, KENT, ENGLAND.



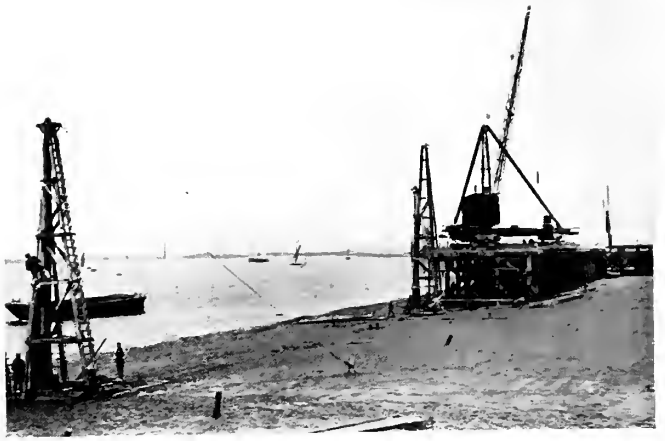
GENERAL SECTIONS.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.



GENERAL PLAN.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.



CONSTRUCTION DETAILS.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

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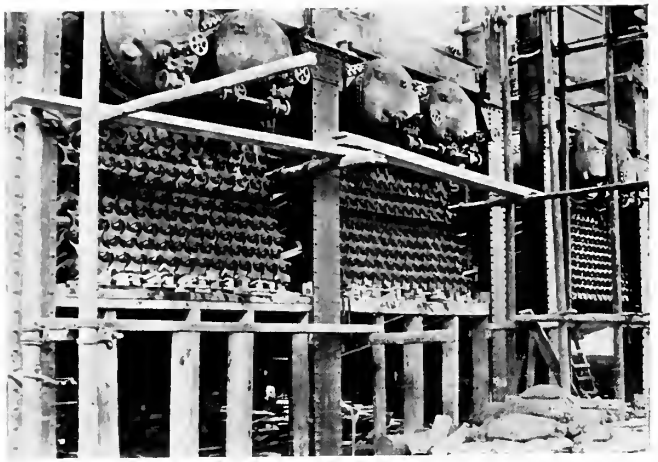

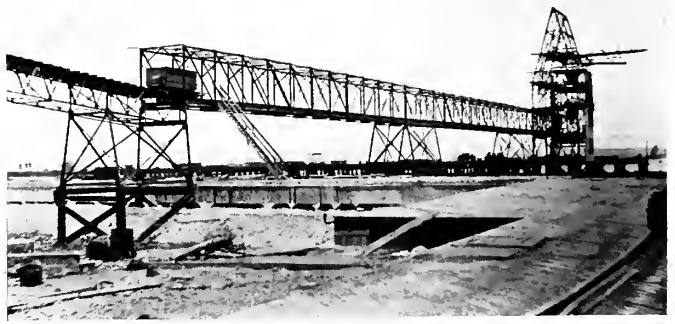

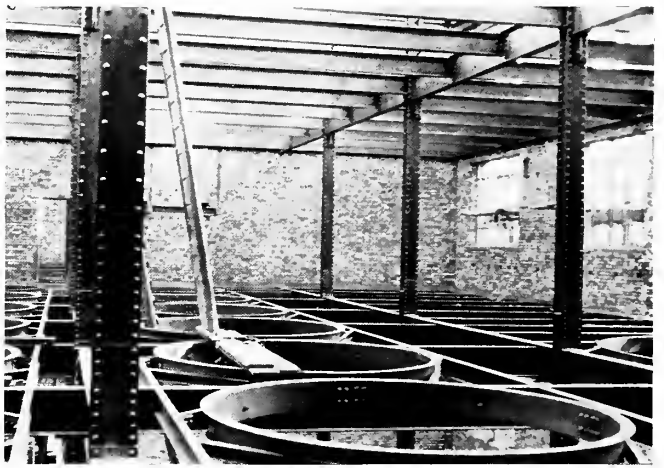

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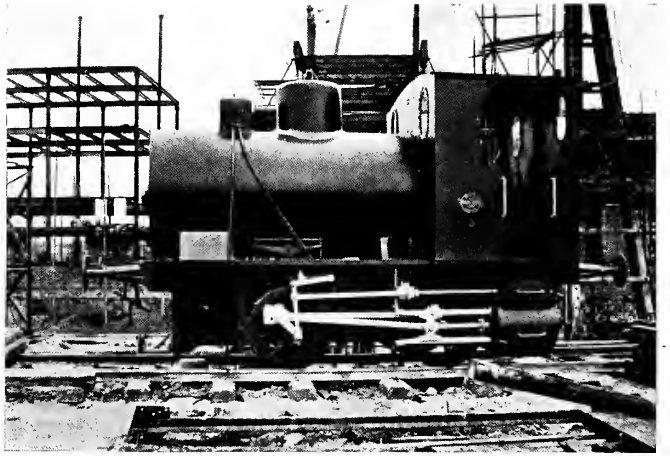

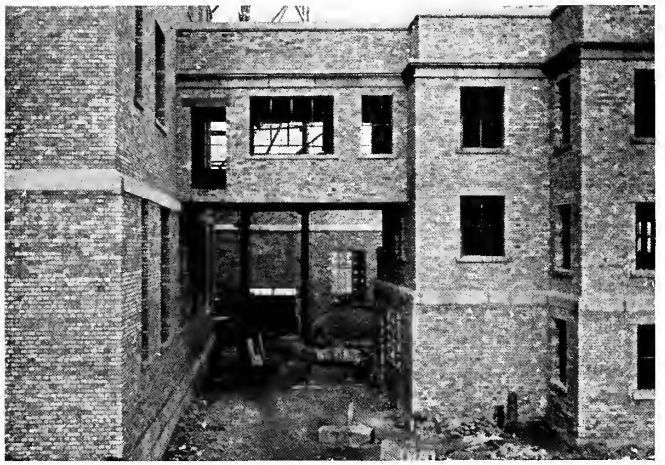

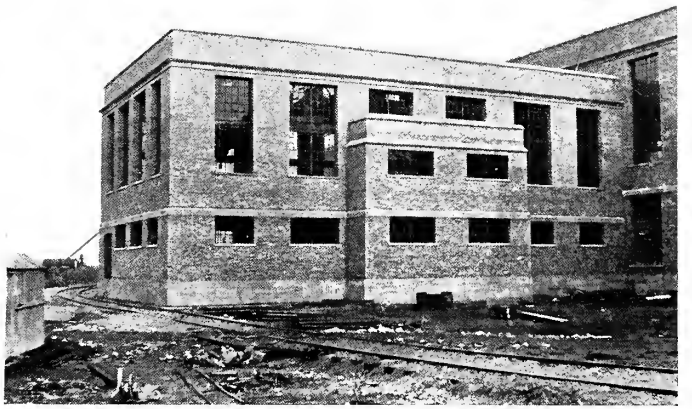

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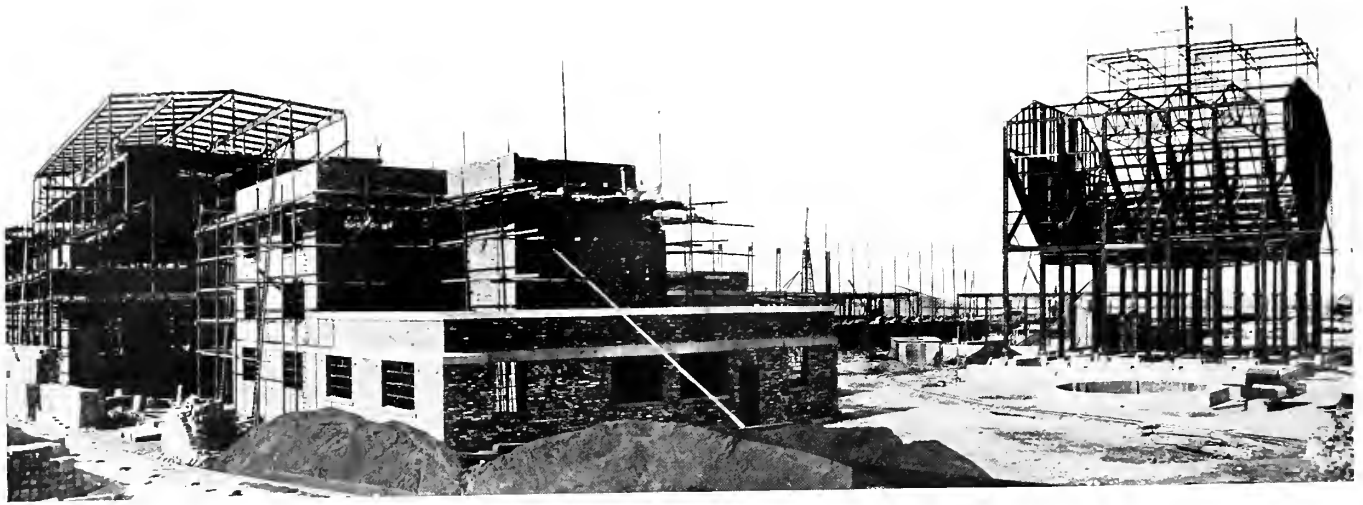
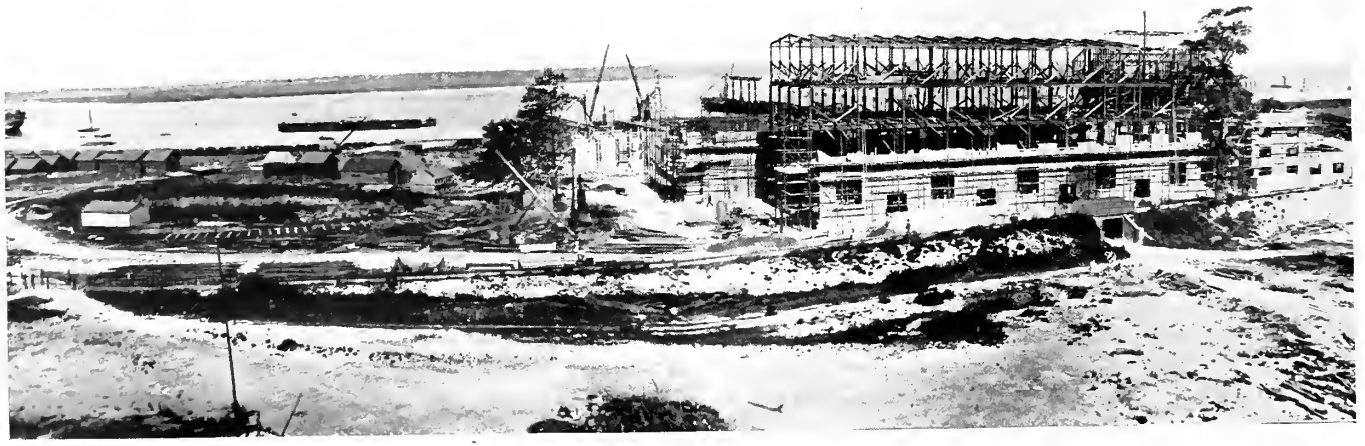
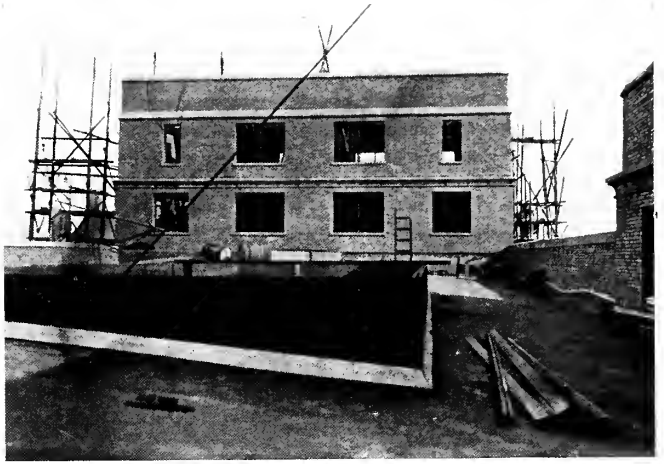
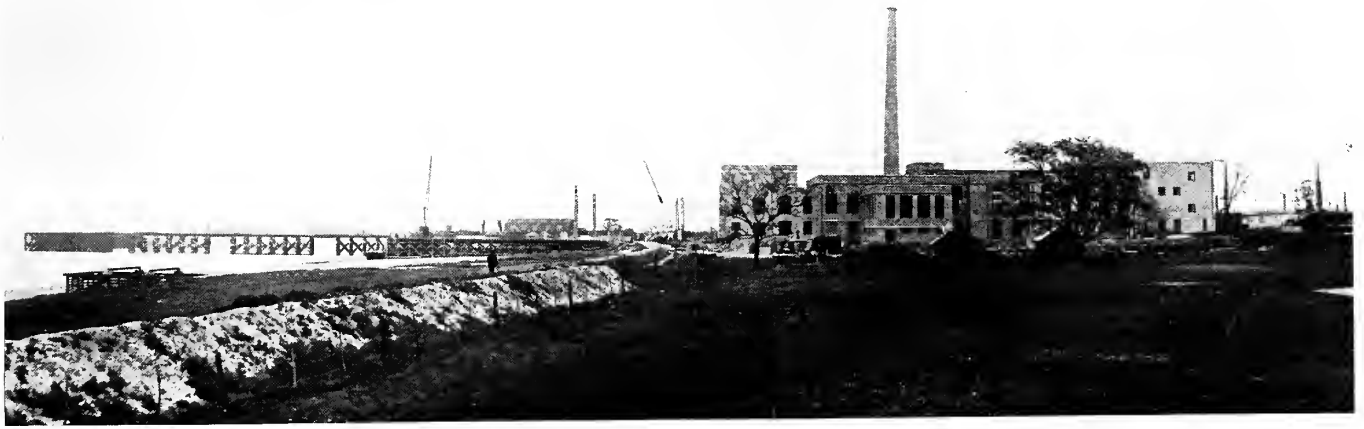




GENERAL VIEWS FROM SOUTH AND EAST. Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.





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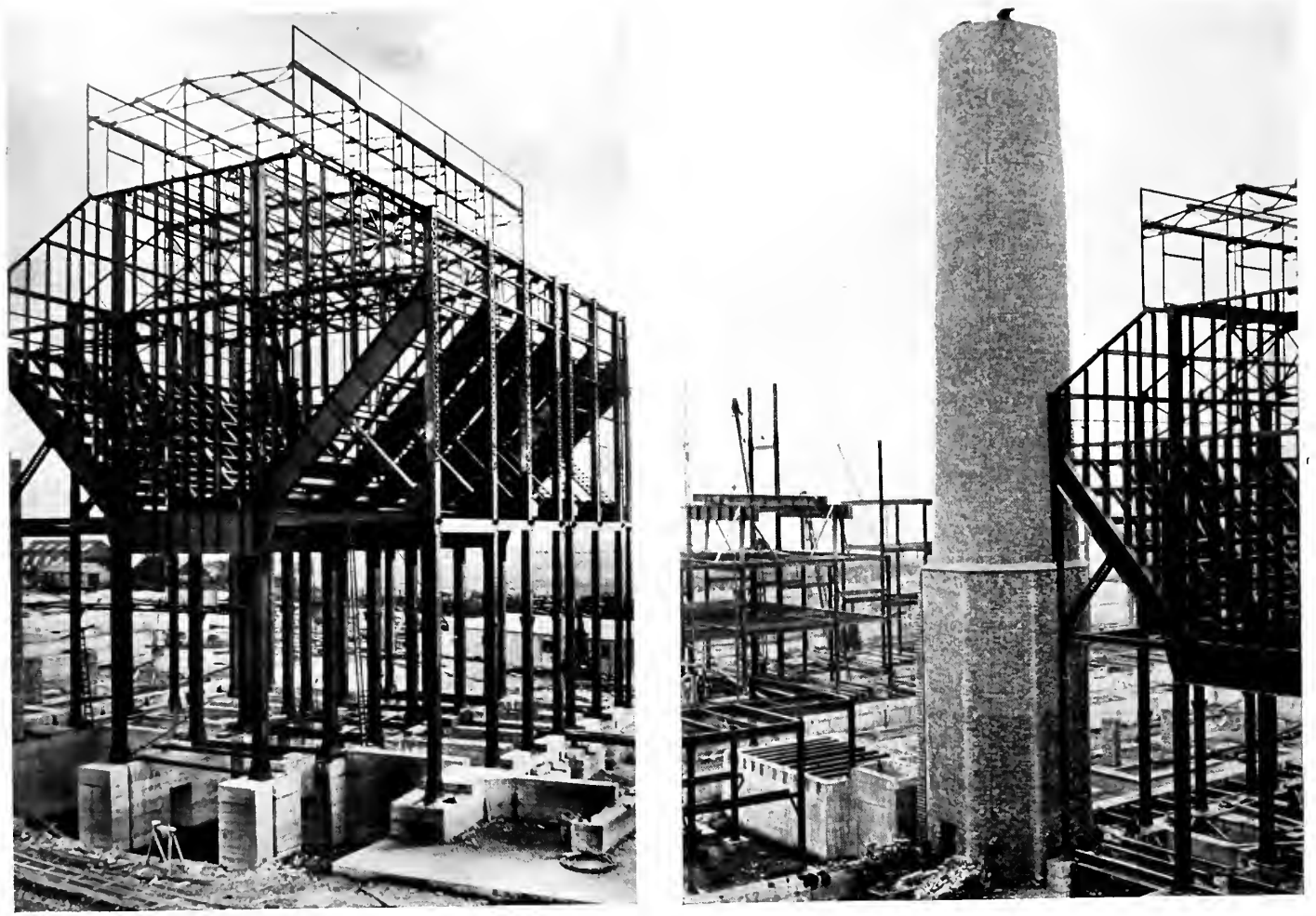
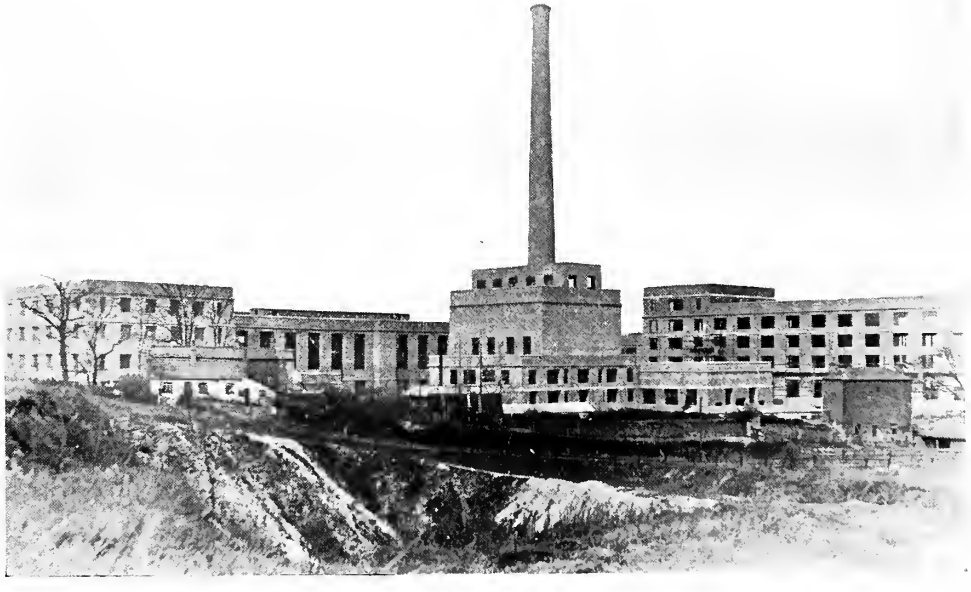


BOILER HOUSE AND CHIMNEY UNDER CONSTRUCTION.
Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.



GENERAL VIEWS OF PLANT UNDER CONSTRUCTION.
Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

are the pumps. 11′ 0″ above this bulkhead is a floor which supports the motors. The rest level of the water is from four to six feet above the pumps, therefore they are always primed for pumping.

The motor floor being above the rest level of the water, the motors are out of danger of possible flooding.

Two pumping units have been installed, each of sufficient capacity to deliver all of the water required for the present installation of the mill and space is available for an additional unit.

Each of these pumping units consists of a vertical high lift type centrifugal pump direct connected to and driven by a vertical induction motor, together with the necessary float control devices, switches, etc. The current for driving these motors is transformed at the Power House at the mill from 440 volts to 2300 volts, and conducted to the well by an underground electric transmission line, and used in the motors at the latter potential.

The operation of the pumping motors is practically automatic. By means of switches either unit may be set to start and stop with the variations in level of the water in the reservoir. At the reservoir are floats which control pilot switches, which, through a low voltage line between the reservoir and the well, control the operation of starting resistances in the 2300 volt pumping motors. The 2300 volt circuit is impressed on the stator or primary side of the motors and is controlled by no-volt and overload circuit breakers and oil switches.

About half a mile from the well and in a direct line between the well and the mill, is an eminence of ground, on the top of which a storage reservoir, holding approximately 500,000 gallons has been built.

The water from the pumps is delivered into this reservoir through a 15″ main, and then by a gravity flow through an 18″ main it is brought to the mill. The elevation of the reservoir is such that a gravity pressure of 65 lbs. per square inch is available at first floor level at the mill.

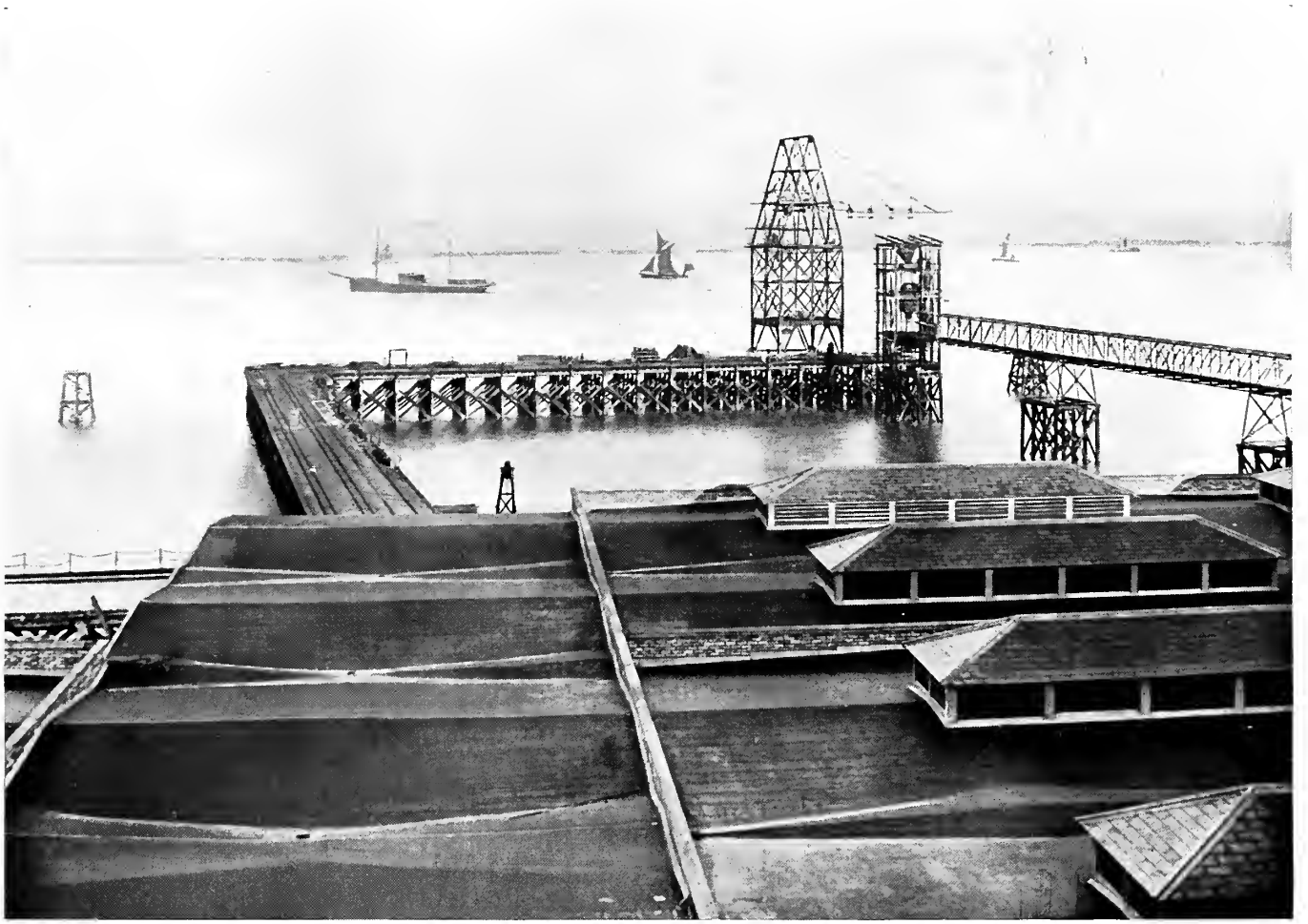
Wharf, Jetty and Pier.—These afford an economical handling of raw materials and finished product, and are arranged to do a general wharfing business beside the work for this mill.

The wharf is 625′ 0″ long by 32′ 0″ wide and connected with the shore by three approaches, 32′ 0″ wide.

About midway between the two end wings of the wharf, the jetty extends out into the river 411′ 0″ long and 28′ 0″ in width.

The pier is 300′ 0″ long by 46′ 0″ wide and the depth of water is sufficient to allow vessels drawing 20′ 0″ of water to come alongside at the lowest flow of the tide.

A large traveling transporter tower with electrically driven hoists and winches unload vessels bringing raw materials and coal. This tower is of structural steel construction, 40′ 0″ by 30′ 0″ at the



WHARF JETTY AND PIER (ROOF OF STOREHOUSES IN FOREGROUND).

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

base and 100′ 0″ high. There are two swinging booms 66′ 0″ up from the deck level so arranged that they may be swung out on either side of the pier so as to discharge vessels berthed on either side.

An electrically driven, double track, 24″ gauge, endless cable railway operating a number of flat top cable cars has been provided to transport raw materials to warehouses. Numerous sidings and turnouts have been provided along the entire length of the pier and at the warehouses so that the main tracks are not blocked by cars awaiting loading and unloading. The platforms of the cable cars are removable and serve as skips of large capacity, the raw materials being loaded directly on to these platforms within the hold of the ship.

In order to separate the coal from the other incoming materials on account of the dirt and dust, another electrically driven industrial railway has been provided. This railway extends from the coal receiving tower to the coal bunkers, which are located within the boiler house, over the steam boilers, and is supported the entire distance by a structural steel trestle.

The unloading and loading of barges and other small craft is carried on at the wharf. At the east end of the wharf there is a 7-ton stationary steam derrick crane, with a 75′ 0″ steel jib for unloading and loading small craft. For those berthed along the face of the wharf, a 5-ton locomotive crane is available.

A branch of the works' railway system extends the entire length of the wharf, and material to and from the wharf is conveyed by the works' locomotive and cars.

Raw Material Warehouses.—On the foreshore an embankment has been made, extending from the original river wall to the front and ends of the wharf, thus reclaiming the area enclosed by the wharf, while at the same time leveling the back land, and it is upon this embankment that the warehouses for all of the various raw materials and chemicals are located.

For the present installation three warehouses have been built, each 200′ 0″ long by 62′ 0″ wide by 30′ 0″ high, and space is available upon the embankment for three more of the same size. The location of the warehouses is such that the various raw materials are stored in direct line from wharf to preparation department of mill.

In the open space, between the Esparto, Rag and Paper Warehouses on the one side, and the Wood Pulp Warehouse on the other, are located the main tracks and sidings of the raw material cable railway. This arrangement allows of the handling of incoming material directly into storage in the respective warehouses, and as the convevors taking the materials to the mill proper are located at the other ends of these buildings, the raw materials are always being moved forward.

BOILER ROOM—COAL HANDLING AND WEIGHING EQUIPMENT.
Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

For unloading the cable cars and handling the materials within the warehouses two 5-ton traveling electric cranes have been installed, and for transferring these cranes to the various crane bays a transfer crane is provided.

At each end of the Wood Pulp Warehouse is a raised platform, on which wood pulp going forward to the mill is unbaled and then placed on the conveyors which take it to the Beater and Bleach Buildings. These conveyors are of the flat belt type, 48″ wide, motor driven.

For taking the colors to the color room and the clay, alum, size, etc., to their mixing room, located on the fifth floor of the Rotary Building, a two-ton electric elevator has been installed with entrance from the Wood Pulp Warehouse.

A portion of the Esparto Warehouse has been partitioned off by reinforced concrete walls and ceiling, thus forming a dusting room where the Esparto is first unbaled and fed through a duster which in turn discharges the dusted Esparto on to a 4-prong belt conveyor 48″ wide, which conveys it to the kier charging room in the Esparto Building.

A 48″ wide belt conveyor with oak flights spaced every four feet has been installed for taking the bales of rags and old papers from their storage to the sorting room in the Esparto Building.

Power Plant.—The present equipment of the mill requires about 2200 boiler horse power, which has been provided for by the installation of 8 horizontal water tube boilers. These boilers are arranged in four batteries of two each, there being two batteries on each side of the Boiler House, with a passageway between them. Over this central passageway are the coal valves, operated from floor level, through which the coal from the coal bunkers overhead is discharged, by gravity, into weighing hoppers, which record the amount of coal going to each boiler, and then on to the feeding hoppers of the stokers. Each boiler furnace is equipped with a chain grate stoker, driven by chain from a motor driven line shaft located beneath the floor.

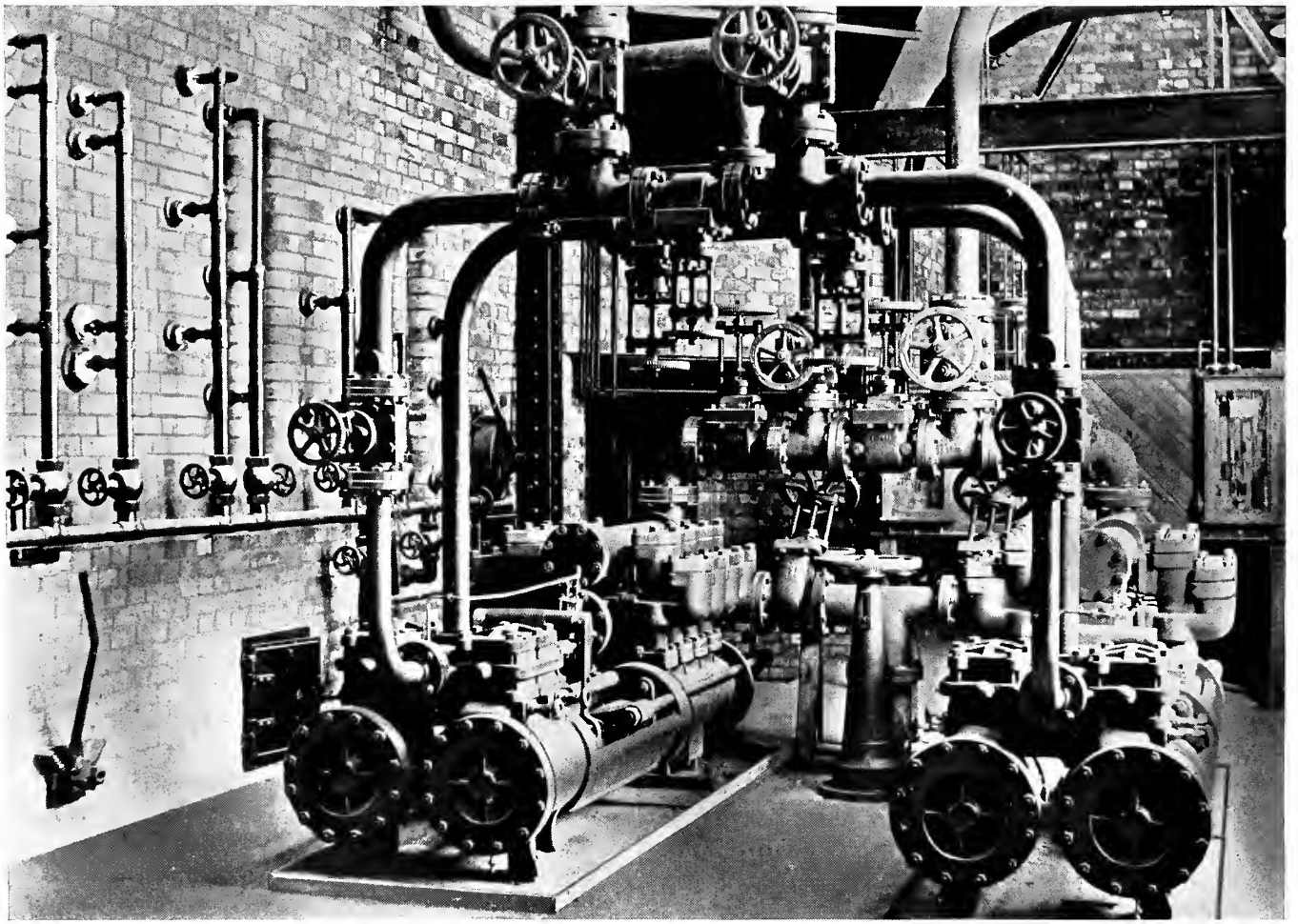
Along the sides of the Boiler House, and at the rear of the boilers are the smoke flues and fuel economizers, each two batteries of boilers having its own economizer.

The chimney, 255′ 0″ in height with an 8′ 0″ diameter flue, is located at one end of the Boiler House so as to become central when the future extensions are built. Another chimney will be provided on opposite side of building, these extensions calling for an exact duplicate of the present equipment.

Opposite the chimney, and to the west of the boilers are two duplex plunger steam pumps.

Between the feed pumps and the chimney is a large open hot well and heater which is used for the collection of such hot water drainage as is suitable for boiler feed purposes.

Beneath the central passageway of the Boiler House is the ash tunnel, into which the ashes are



BOILER ROOM—FEED PUMPS AND PIPING.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

drawn from the boiler ash pits and then carried away in cars which are raised to ground level by an electrically driven elevator located at the eastern end of the ash tunnel.

At the other end of this tunnel and underneath the space occupied by the boiler feed pumps and the open heater are two additional rooms, in one of which is a 40 K. W. steam driven alternator which provides current for stokers, and the small amount of lighting required when the mill is not in operation. The other room is used for boiler testing purposes and contains weighing scales and tanks for measuring accurately the amount of water used in making evaporative tests on any of the boilers.

The fresh water supply is hard and requires treatment before feeding to the boilers. A water softening plant of 6,600 gallons per hour capacity has been installed, and the softened water is pumped to a storage tank on the top of the Fire Pump House, and from there is supplied through a series of feed water heaters and economizers to the boilers.

Steam is drawn from the boilers into a 12″ diameter main steam header which encircles the Boiler House. Branches from this header distribute the steam to the Preparatory Department, the fire pumps and to the Paper Making Department and Power House.

All of the high pressure drainage is automatically returned direct to the boilers by a gravity return system, while the low pressure drainage is returned through the open heater and hot well mentioned before.

Connecting the Boiler House with the Machine Building is an elevated covered passageway, and continuing at the same level across the Machine Building basement to the Engine House is an open gallery, the two serving as a connecting link between the Boiler and Engine Houses. All of the steam mains and return piping to and from the Boiler and Engine Houses as well as the electrical conductors from the Engine House to the various parts of the mill run along this passage. The controlling valves and switches for distributing the steam and electrical current from these mains are located within easy reach from it.

This passageway is a feature of the Power Plant. It centralizes the controlling valves and switches and facilitates supervision of this department. (See section of Machine Building opposite page.)

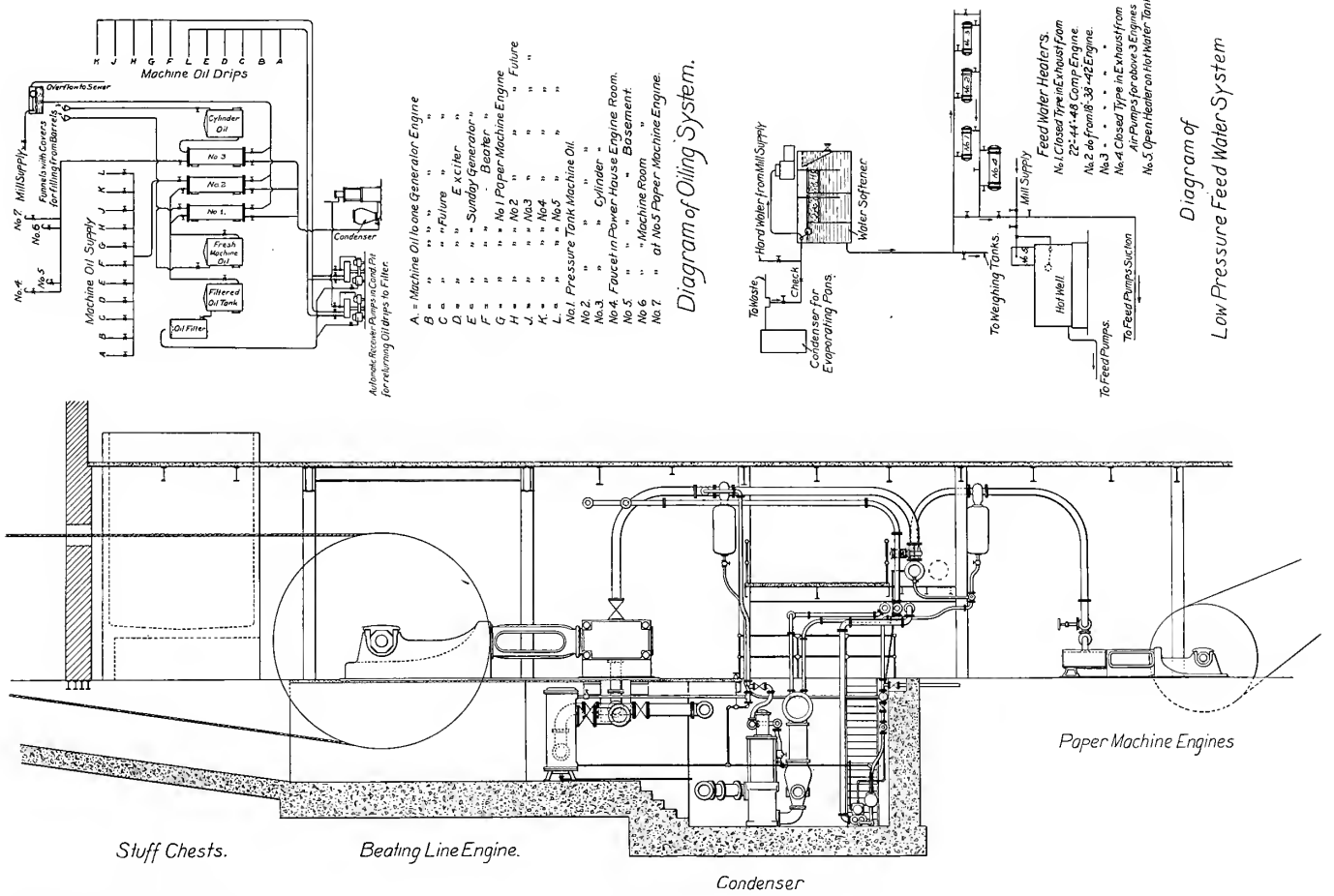
To the south of the gallery are the steam engines driving the Paper Machines. These are duplex, each composed of two 12″ x 26″ simple non-condensing engines, of the variable speed type, and built to run at any speed between 40 and 160 revolutions per minute.

On the north of the passageway is a 22″ x 44″ x 48″ Corliss type, horizontal cross compound condensing engine driving the line shafting in the first story of the Beating Engine Building.

The Power Distribution Gallery

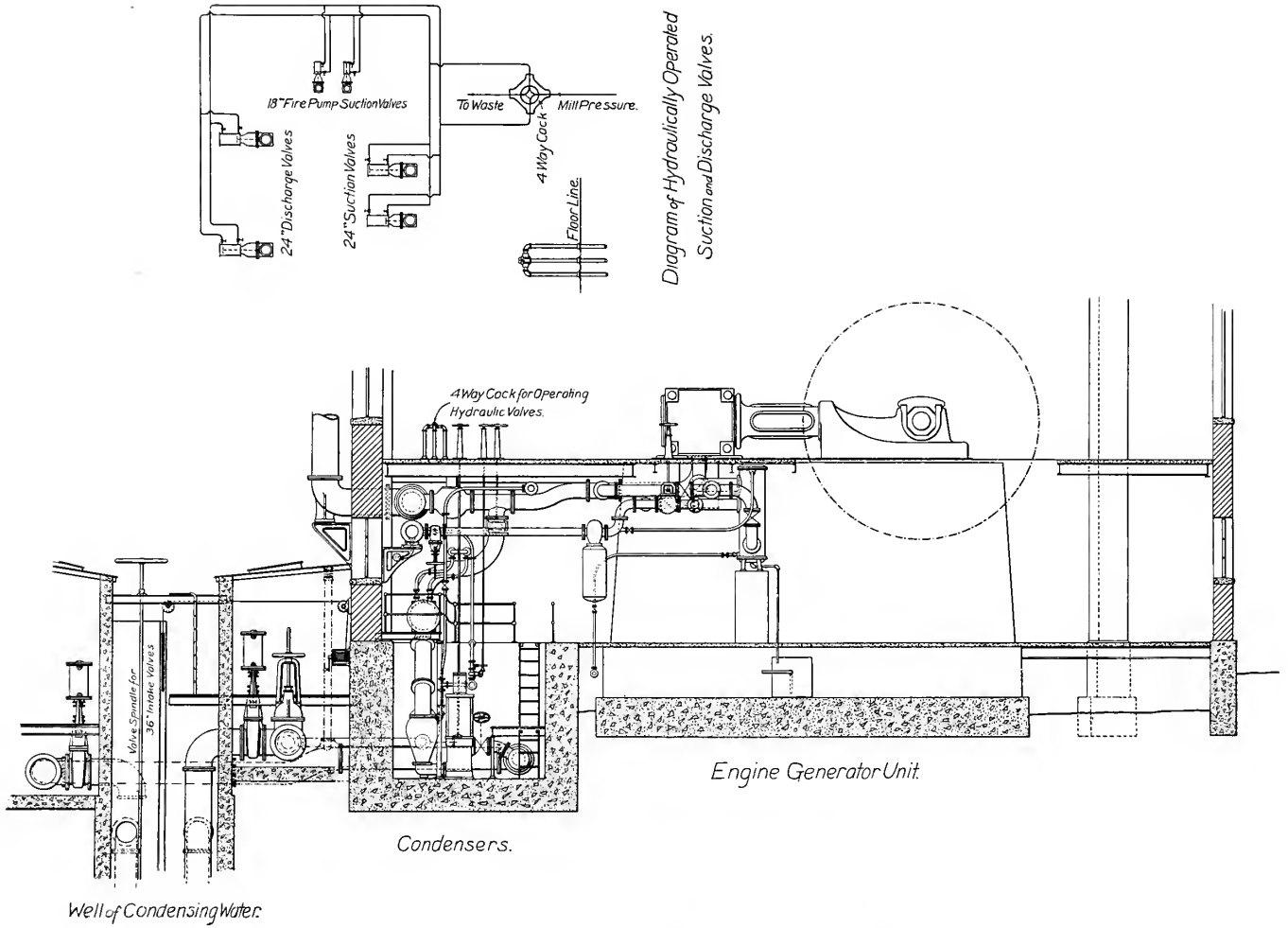
POWER DISTRIBUTION GALLERY.
UNDER MAIN FLOOR MACHINE ROOM, AND CONNECTING BOILER AND ENGINE ROOMS.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.


Machine Oil Drips
Overflow to Sewer
Cylinder Oil
No 3
No 2
No 1.
Fresh Machine Oil
Filtered Oil Tank
Oil Filter
Condenser
Automatic Receiver Pumps in Cond. Pit for returning Oil drips to Filter.
Machine Oil Supply
Mill Supply
Funnels with Covers for filling from Barrels
A = Machine Oil to one Generator Engine
B = " " " " "
C = " " "Future " "
D = " " Exciter "
E = " " "Sundry Generator" "
F = " " " Dearter "
G = " " " No 1 Paper Machine Engine
H = " " " No 2 " " "Future
J = " " " No 3 " " "
K = " " " No 4 " " "
L = " " " No 5 " " "
No 1. Pressure Tank Machine Oil.
No 2. " " "
No 3. " " Cylinder "
No 4. Faucet in Power House Engine Room.
No 5 " " " Basement
No 6 " "Machine Room "
No 7 " at No 5 Paper Machine Engine.
Diagram of Oiling System.
To Waste
Check
Condenser for Evaporating Pans.
Hard Water from Mill Supply
Water Softener
To Weighing Tanks.
Hot Well
To Feed Pumps.
To Feed Pumps Suction
Mill Supply
Feed Water Heaters.
No 1 Closed Type in Exhaust from 22"x 44"x 48 Comp. Engine.
No 2 do from 18"x 38"x 42" Engine.
No 3 " " " " "
No 4 Closed Type in Exhaust from Air Pumps for above 3 Engines
No 5 Open Heater on Hot Water Tank.
Diagram of Low Pressure Feed Water System
Paper Machine Engines
Stuff Chests.
Beating Line Engine.
Condenser

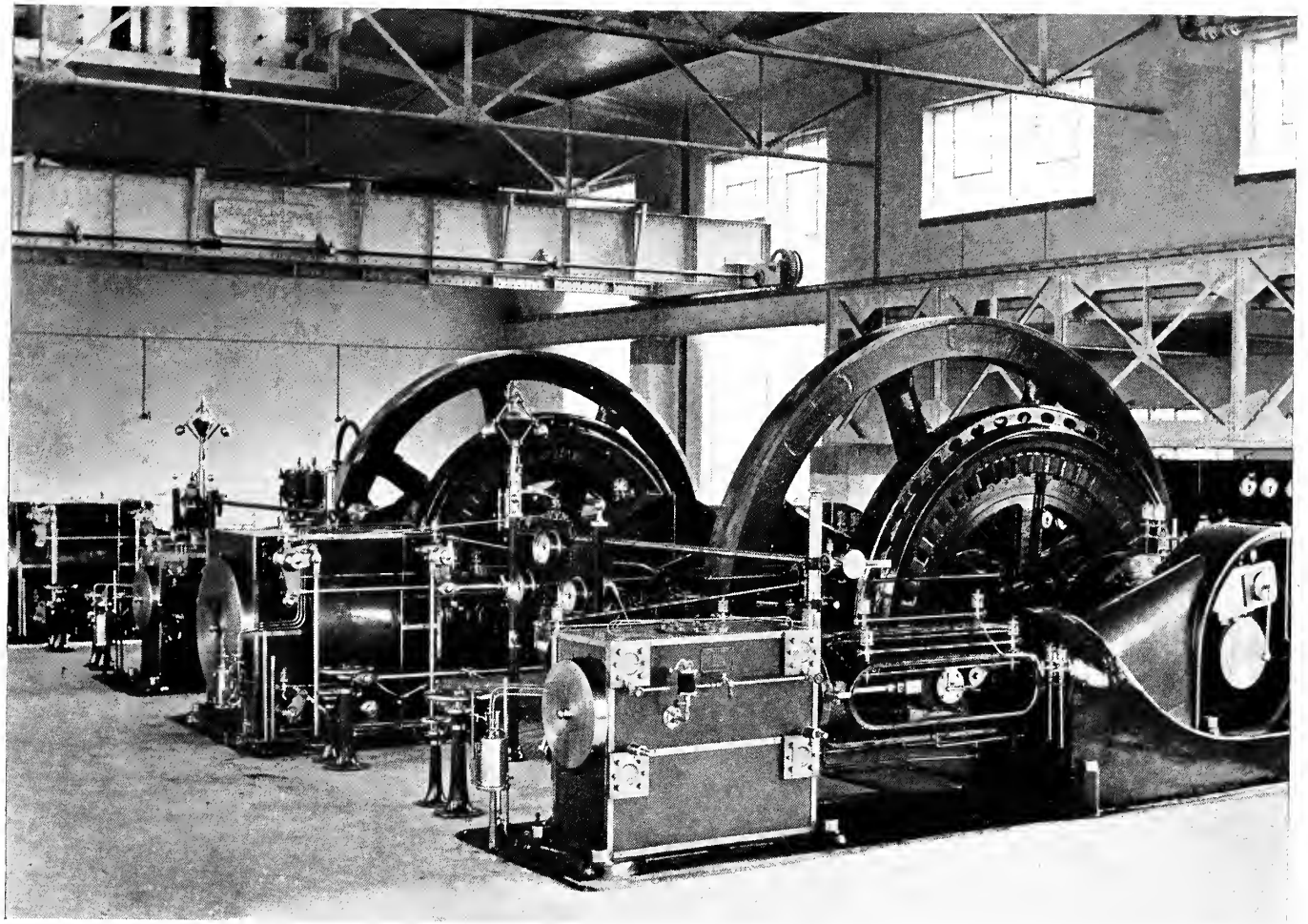
MACHINE BUILDING AND POWER DISTRIBUTION GALLERY.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.



SECTION MAIN POWER ROOM.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.



MAIN POWER ROOM.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

To the west of the Machine Building is the Engine House. Here are located two 400 K. W. direct connected generating units, while space is provided for an additional unit of the same size. These generators are three phase alternating current machines and develop a potential of 440 volts, the working pressure of the electrical system. They are direct connected to 18" x 38" x 42" horizontal cross compound condensing steam engines. The condensers for these steam engines are located in the basement of the Engine House.

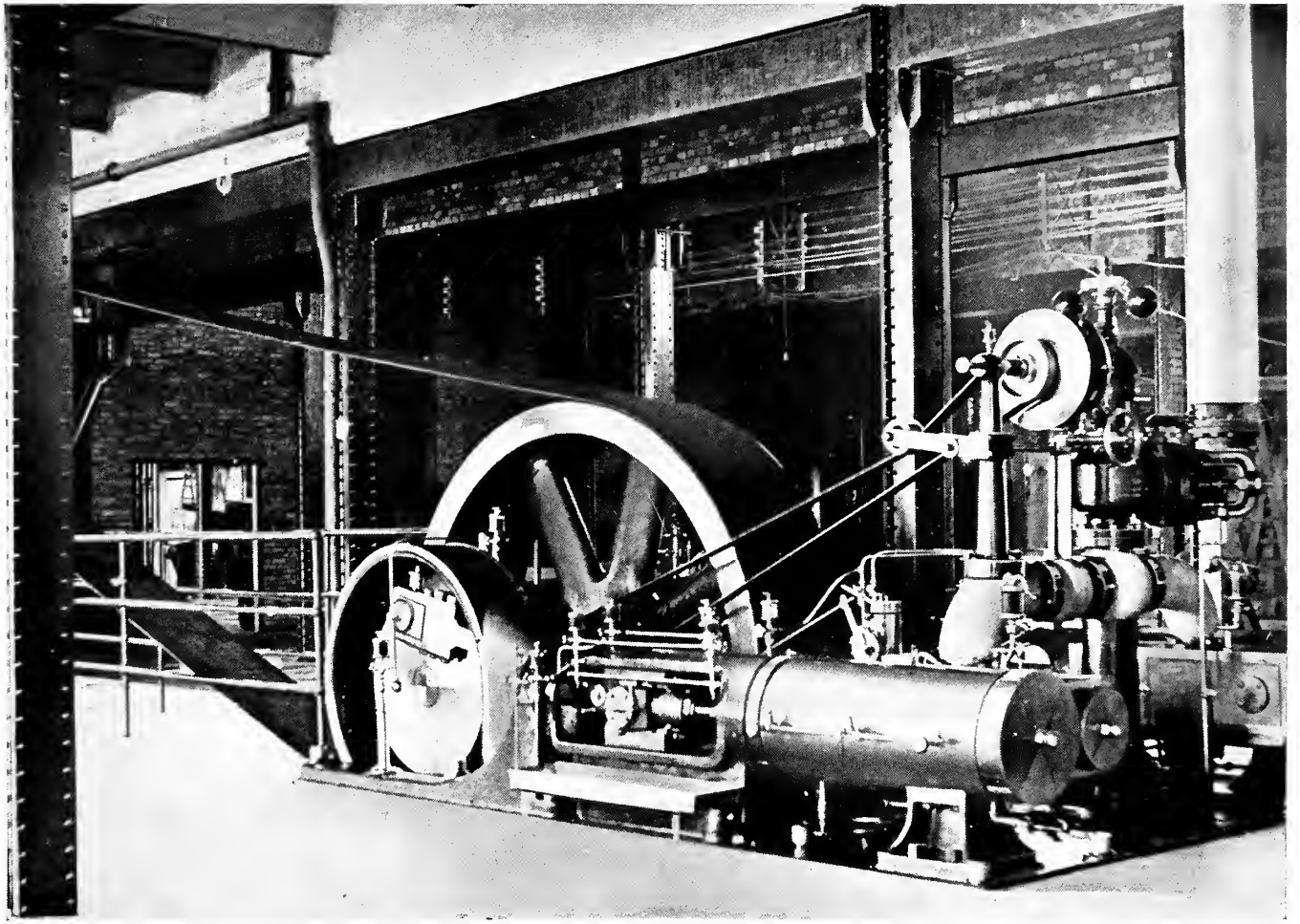
The cooling water for these condensers as well as for the beater engine condensers is obtained from the Thames.

Located outside the Engine House are two reinforced concrete sump wells, which alternately serve as suction and discharge wells for the condensers. From the bottom of each of these sump wells and extending out into the Thames is a 36" diameter pipe, the invert of each being 3' 0" below extreme low tide, and as each pipe is used for suction and discharge they are level the entire distance from the well to their outlet in the river. The river ends of these pipes are laid well apart to avoid the short circuiting of the warm discharge water into the suction pipe and a further precaution was taken by arranging to change the direction of flow in these pipes with the ebb and flow of each tide. On the suction and discharge pipes of each of these condensers are hydraulically operated gate valves which are opened and closed respectively by the movement of a small multiported cock located on the main floor of the Engine House. (See diagram of piping.) This multiported cock allows water pressure to act on the proper sides of the pistons which move the hydraulic valves, the whole movement of the six valves being simultaneous and accomplished in less than one minute.

Besides the two 400 K. W. units mentioned above there are also two 75 K. W. generating units direct connected to and driven by high speed vertical non-condensing engines and a 75 K. W. motor driven exciter. One of these 75 K. W. steam sets is for supplying alternating current for operating such machinery as is required on Sundays and holidays, the other steam set being used as a relay to the motor exciter set which excites the fields of the large generators.

In front of the main generators is an eleven-panel switchboard with a very complete installation of switches, circuit breakers and meters for controlling the electrical current and distributing it to the various points about the mill.

The electrical distribution for power is a three-phase three-wire system which has 440 volts across any two wires. From the main switchboard in the Engine House, feeders supply the current to a number of subsidiary switchboards located at distributing centres in various parts of the mill, and from these switchboards branches radiate to the



PAPER MACHINE ENGINE.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

motors, each of which is protected by a switch and a set of fuses in addition to the motor starting switch. With the exception of variable speed drives of the paper machines and the equipment driven from the line shafting in the Beater Room basement, all of the various machinery is motor driven. There are about 50 motors in the present installation, ranging from 2 H. P. to 150 H. P. principally of the "squirrel cage" induction type.

Both alternating and direct current are used for lighting; the general illumination is by metallic filament incandescent lamps on the alternating current, except in the Beater Room, Machine Room and the Office.

Preparatory Department.—This department of the plant is designed to produce a large variety of papers from the many kinds of raw materials.

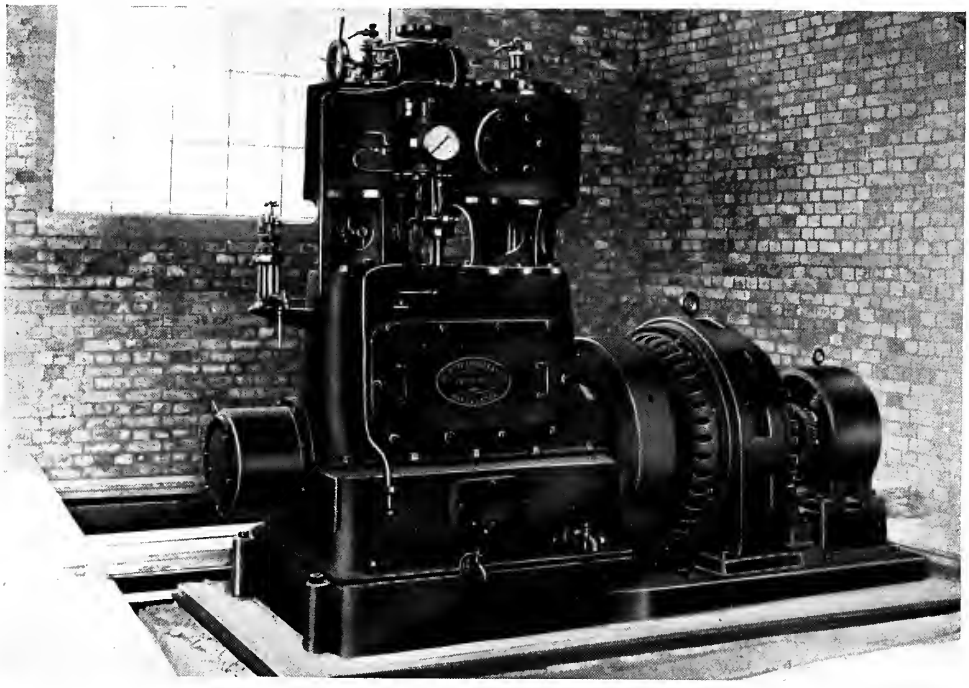
The Esparto, Bleach, and Rotary Buildings may be regarded as one building, 234′ long by 78′ wide, as the floors are at the same elevations. The Causticizing and Recovery Building is divided into a Rotary Furnace room 114′ long by 64′ wide, one story high, and a Causticizing Room 80′ long by 64′ wide, two stories high, in one corner of which is the Evaporating Room, 50′ long by 25′ wide, three stories high. The Color Room extends as a bridge over the passage between the Beater Building and the Wood Pulp Warehouse, upon the level of the main floor of the Beater Building.

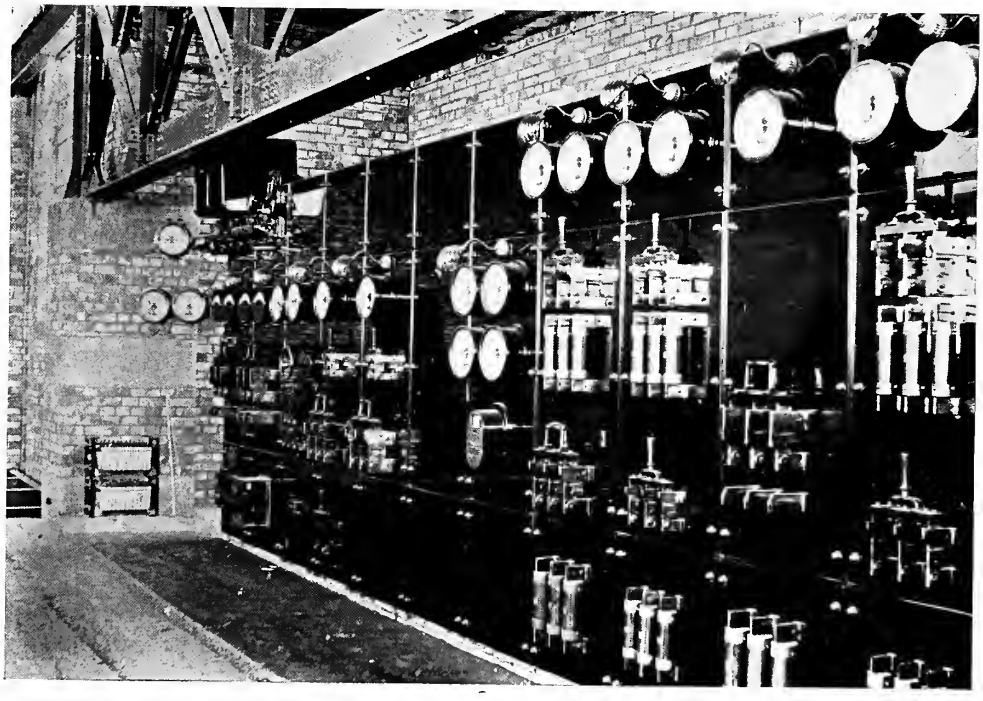
The first three floors of the Esparto Building contain the greater part of the equipment of the Esparto preparing plant, including a battery of seven boiling kiers 9′ in diameter by 9′ high, conveyors, feeding tanks, breakers, drum washers, kollergangs, storage chests, etc., for the proper treatment of Esparto for bleaching. The top floor of this building is utilized for the unbaling and sorting of rags and old papers. There is also ample space available on this floor for storing a quantity of sorted rags and old papers before sending forward to the rag and paper dusting room.

The third and fourth floors of the Bleach Building are devoted to further treatment of rags and old papers. On the top floor are the rag and paper dusters, the rag cutters, and dust collecting system. The rags and old papers are discharged to belt conveyors, which distribute them to the storage bins.

Pulps requiring bleaching are brought from the warehouse by a 48″ belt conveyor to the second floor of the Bleach Building, passed through a kneader, and discharged into a storage tank, from which it is pumped to the bleaching towers. The rest of the space on the first and second floors of this building is devoted to the Bleaching Plant.

Five bleach towers for Esparto and four for chemical fibre have been installed, with space available for two Esparto and three fibre towers more when the future equipment is installed. The previously prepared Esparto and wood fibre is pumped from receiving chests to the first of the series of bleaching





SUNDAY UNIT AND SWITCHBOARD.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

towers by a 12-inch circulator pump, which circulates the pulp within the tower and then passes it along to the next, and finally to stuff chests, of which there are two for Esparto pulp and two for wood pulp.

On the second floor of this building are the rotary boilers for treating rags and old papers. The treated rags and papers from rotary boilers are then taken to the washers, located on the main floor of the Beater Building, and after being washed are pumped to rifflers and screens, from which they flow to the wet machines.

On the first floor of the Rotary Building of this mill is an installation of wet machines arranged in units of two each, and so piped as to be available for bleached Esparto pulp, for bleach sulphite and soda pulp and for half stock from rags or old papers.

It is to these wet machines that all raw materials entering the preparatory department finally come, to be taken off in web or leaf as prepared half stuff ready to be sent direct to the beaters or placed in storage.

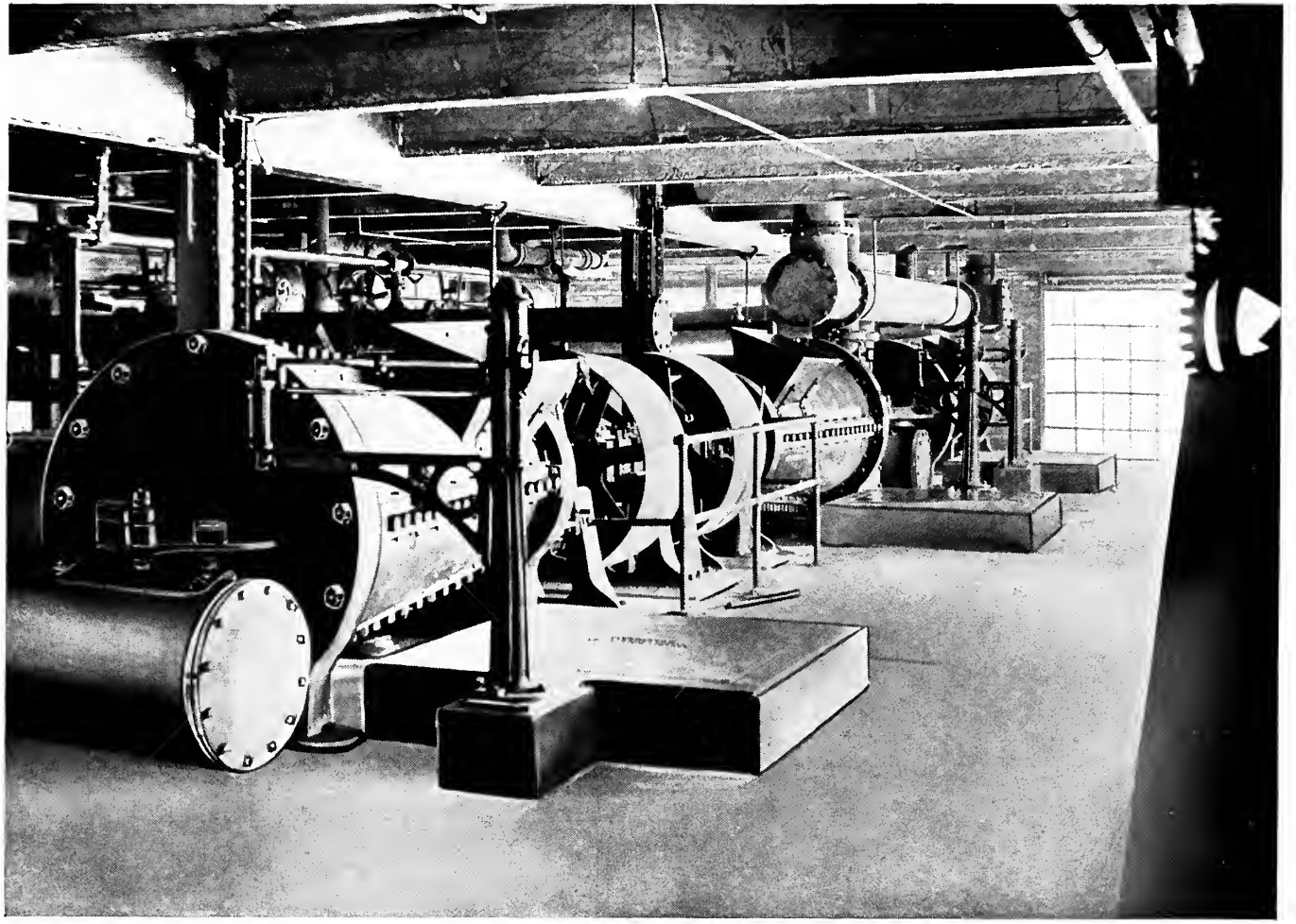
The fourth and fifth floors of the Rotary Building are devoted to the preparation and storage of various liquors, such as bleach, alum, size and clay. These materials are brought to the fifth floor of this building direct from their storage by a two-ton electric lift, and without being carried into the mill.

On the fourth floor, and immediately below the various mixing tanks, are the storage tanks for the prepared liquors. These are at a sufficient elevation to give a gravity flow to the smaller measuring tanks over the beaters and bleaching towers.

The Color Room is devoted entirely to the storage and mixing of colors. A complete installation of color mixing equipment has been put in and the usual dirt and vapors occasioned and arising from the mixing of colors in the Beater Room are avoided.

Paper Making Department.—Although laid out for five paper machines, with the exception of the main line shaft in the Beater Building, the arrangement of each paper machine with its power units, beaters, refiners, pumps, chests, piping and other accessories, is such that each machine is independent of the others.

Adjoining the Rotary Building is the Beater Building. This building is 255′ long by 78′ wide, and two stories high, an addition being required when the future paper machines are installed. In the northeast corner of the basement, midway between the first and second floors, is a gallery 90′ long by 19′ wide, on which are located pulpers of the cone breaker type, one for each paper machine. A 48″ belt conveyor connects the pulper platform with the unbaling platform in the Wood Pulp Warehouse, and brings from storage to the mill various wood pulps not requiring bleaching. The pulp is passed through the pulpers and then discharged into chests, from which it is pumped



CONE BREAKERS FOR OPENING DRY GROUND WOOD PULP.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

direct to the beaters. It is possible to have prepared stock ready to be pumped to the beater as soon as a beater is let down. The saving of time in filling the beaters will be readily appreciated.

On the main floor are nine 1200-pound beaters, four 1600-pound washers with 4-cylinder washers each for washing old paper stock, and one 1300-pound washer for rag stock, and the motor-driven Jordan engines.

At right angles to the Beater Building is the Machine Building, 270′ long by 144′ wide, with an extension of 91′ long by 32′ wide at the Finishing Building end. This building is two stories high, having the paper machines on the second floor, the pumps, chests, piping, drives, etc., on the first floor.

Each machine has two vertical reinforced chests, 12′ in diameter, which extend up through the main floor and are open at the top.

The fourdrinier end of the No. 4 machine has been equipped with a new device for raising and lowering the entire wet end.

For dealing with the effluent water, each machine is equipped with a large settling tank, to which the water from the couch pits is pumped. These tanks are at a sufficient elevation to allow of a gravity flow of the recovered stock to the beaters, and the overflow water is used in the pulpers, beaters and refiners.

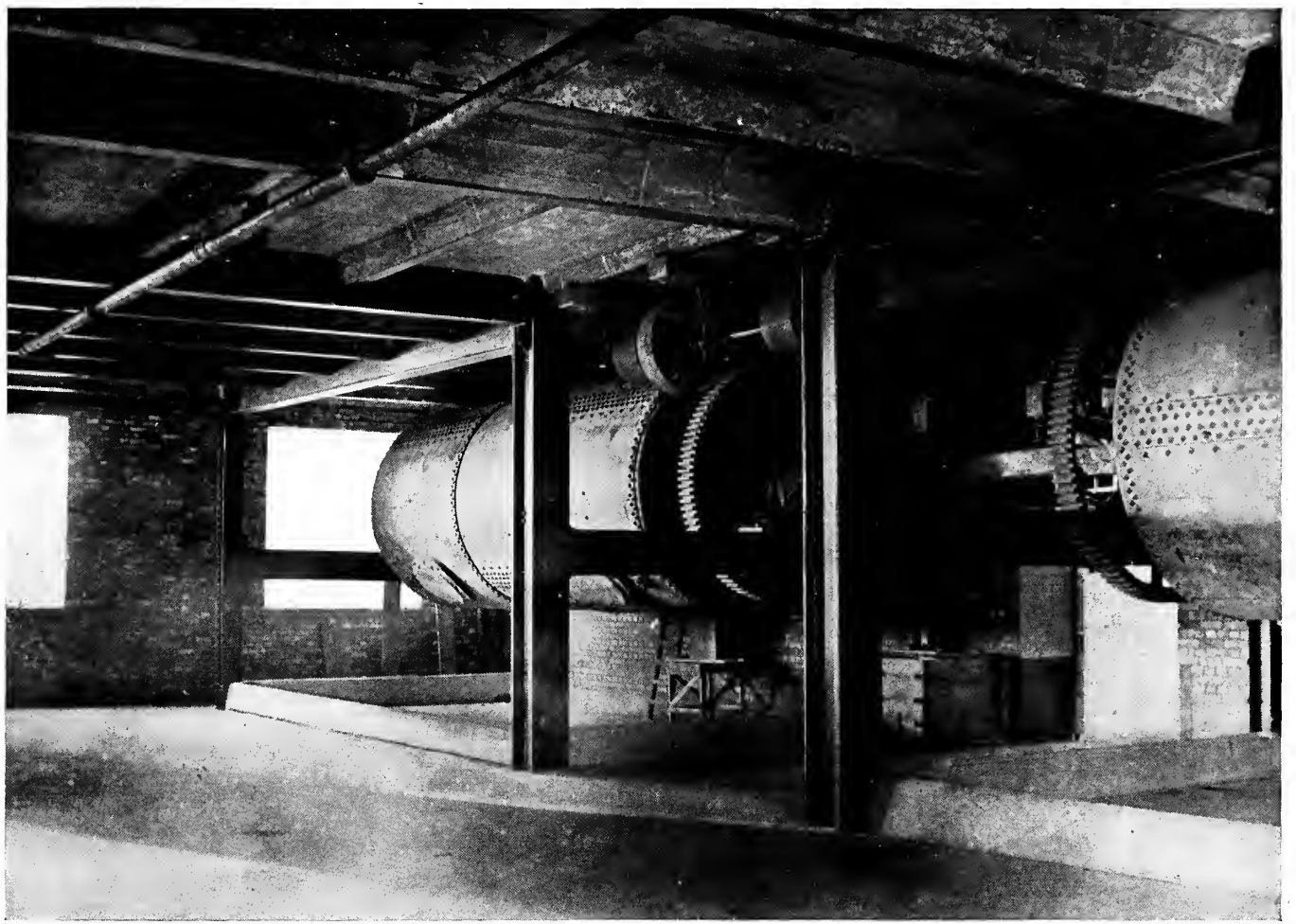
A complete equipment of calendars, reels, slitters, and double drum rewinders has been installed for each machine and the paper is delivered to the Finishing Building ready for wrapping and shipping.

For dealing with the broke, pulpers have been installed on platforms underneath the passageway in front of the machines, the broke being dropped through an opening in the main floor to these platforms. Underneath these pulpers are storage chests, into which the pulped broke is discharged, and from which it is pumped to the beaters.

The constant line shafting for each machine is motor driven. The variable portion of the machines are driven by an improved drive with continuous rope drive, counter shafting, etc., in the basement.

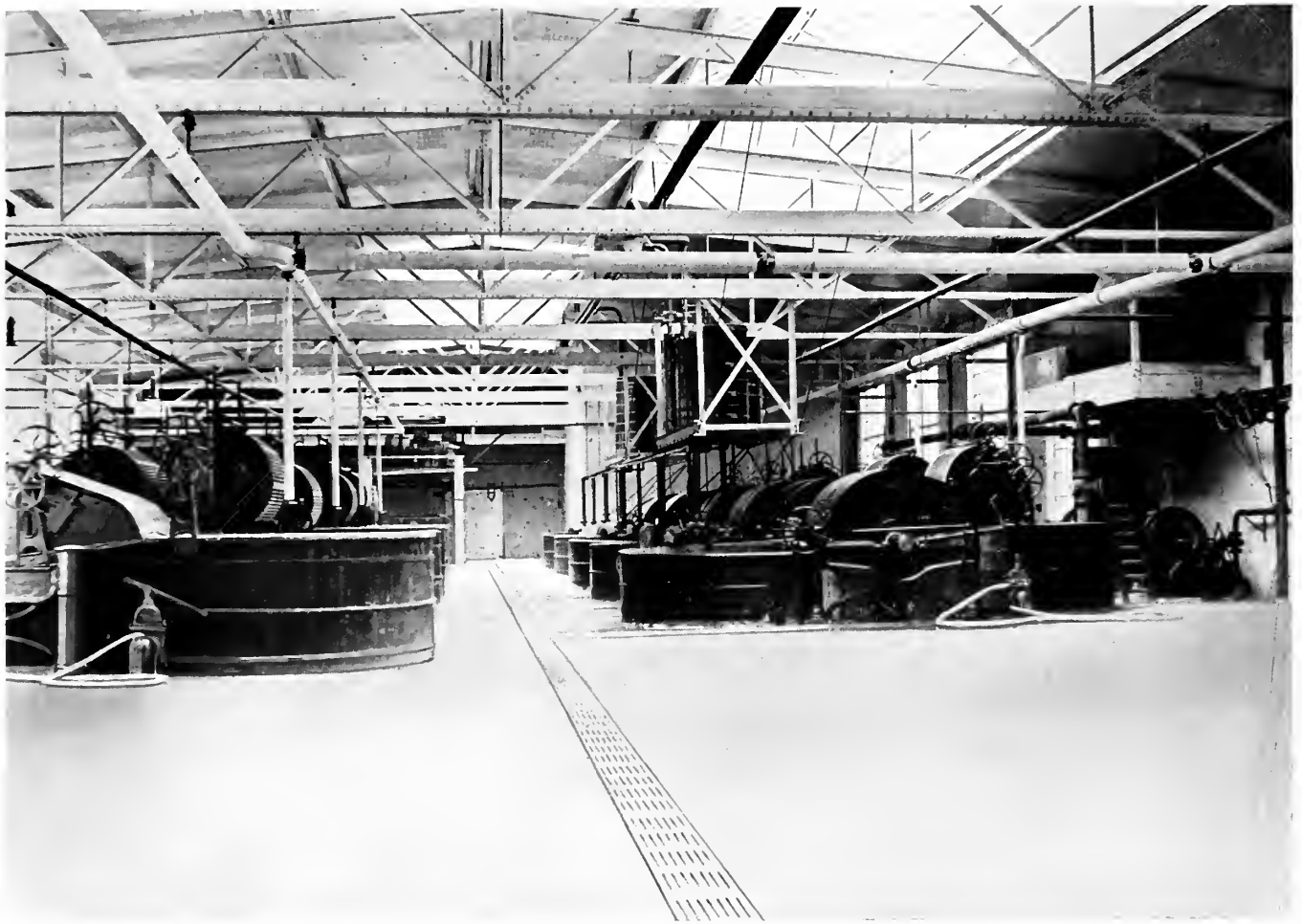
At the end of the Machine Building is the Finishing Building, 182′ long by 92′ wide and four stories high. The first floor is used as a shipping room, and the arrangement for tracks on each side the full length of this building greatly facilitates the handling of material by railway and to boats lying at the pier.

Miscellaneous.—A system of settling tanks, filters and other accessories has been installed for recovering the waste fibres contained in the effluent waters. Besides the white water settling tanks in the Machine Room, four 72″ effluent filters have been put in, one of which is on the first floor of the Machine Building, into which is piped all white water overflows, as well as all washing up waters from the settling tanks, and various chests. The other three filters are on the first floor of the Esparto



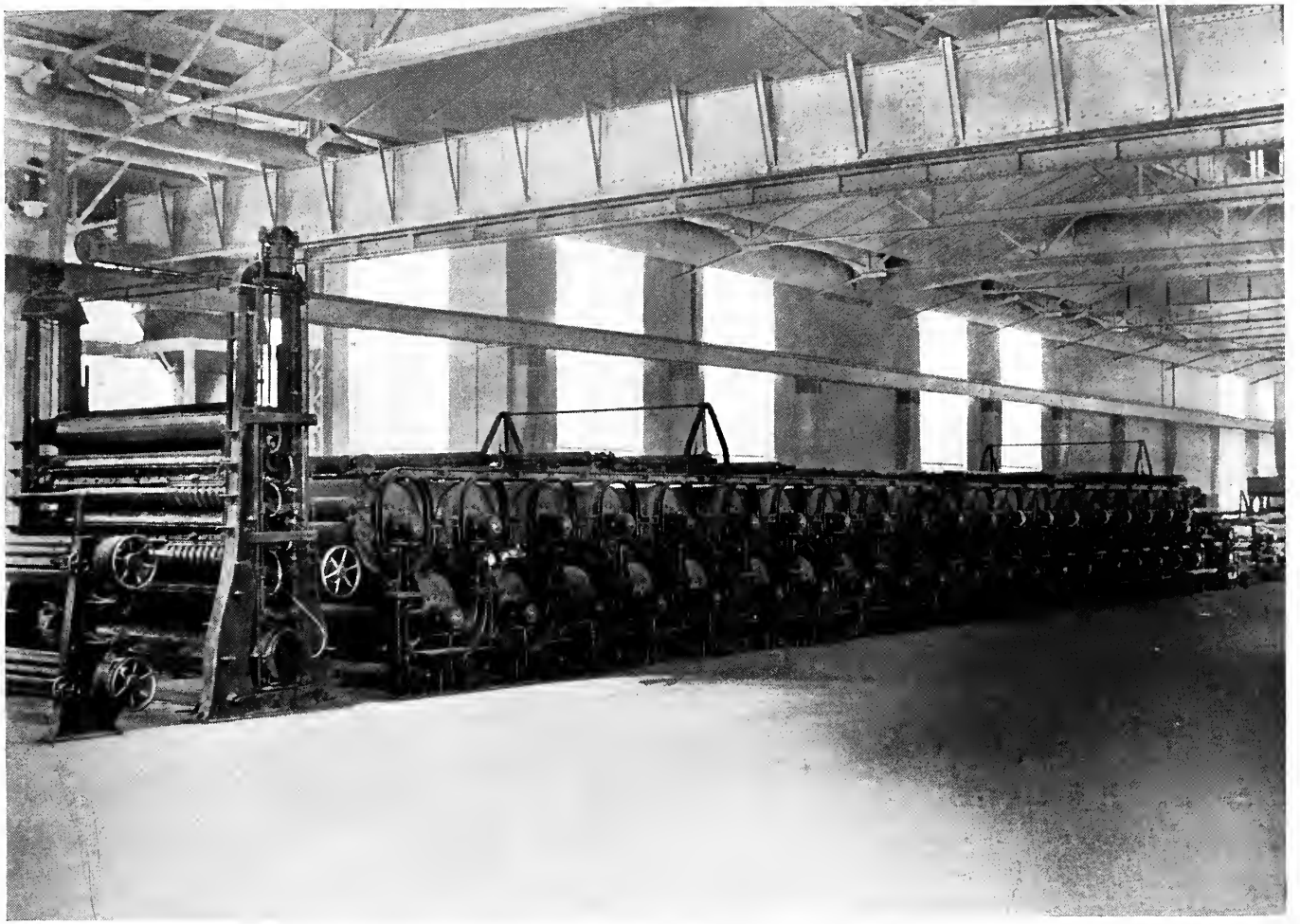
A CORNER IN THE ROTARY BOILER ROOM.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.



BEATING ENGINE ROOM.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.



PORTION OF MACHINE ROOM.

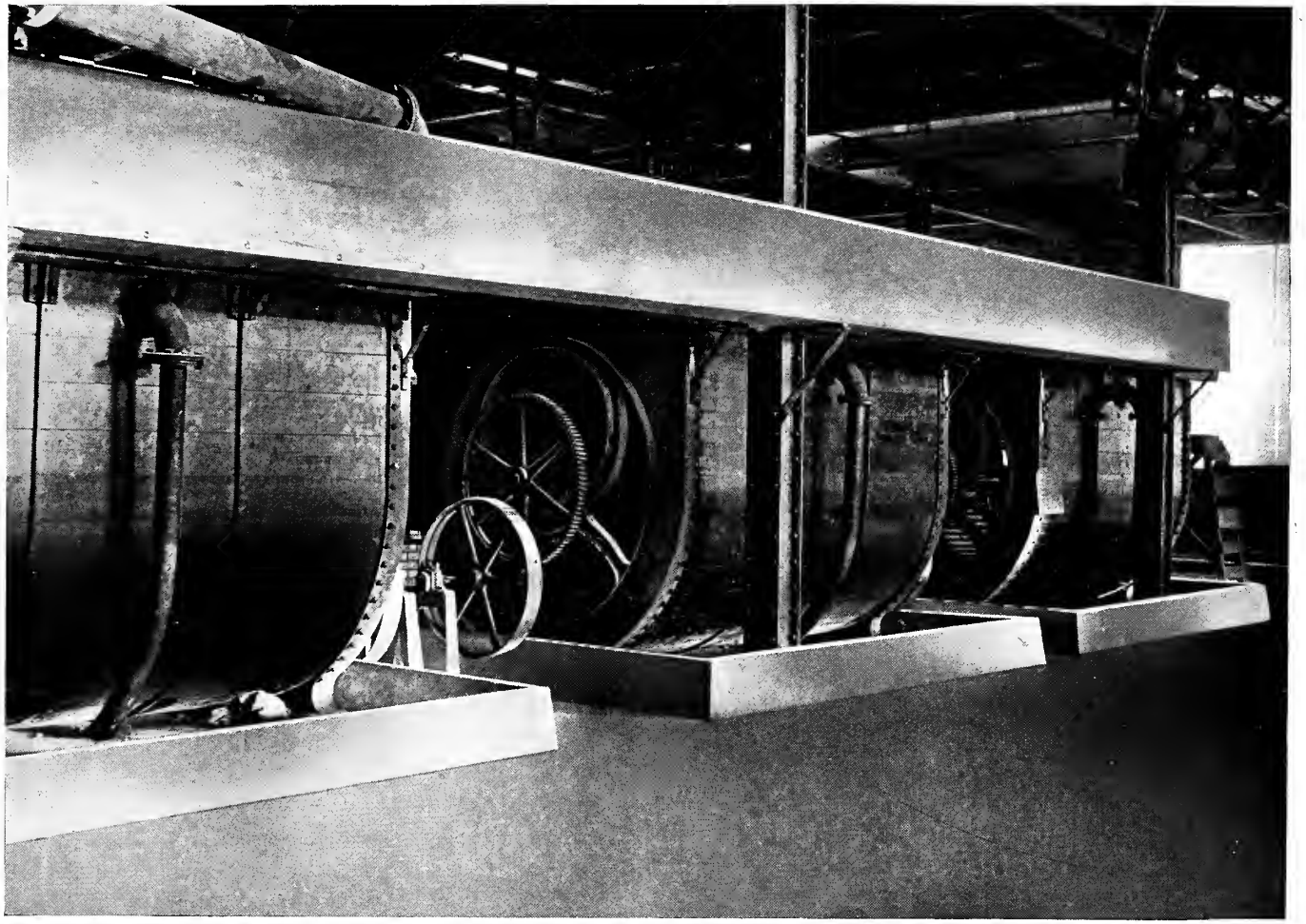
Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

Building, and deal with all effluent and wash-outs from the Beater, Rotary, Bleach and Esparto Buildings.

For general repair work, exceedingly well equipped Smithy and Machine shops have been provided. The Machine Shop is on the first floor of the Machine Building, underneath the dry end of the No. 1 and No. 2 Paper Machines, and contains electrically driven lathes, radial drills, shaper and planer, and other incidental metal and wood working machinery, also a roll grinder 150″ wide. The Smithy is 42′ long by 28′ wide, one story in height, and contains two large forges with electrically driven air blasts, power hammer, etc.

For fire protection purposes, there are two 1000 gallon Underwriter fire pumps, a 10,000 gallon sprinkler tank, and a complete system of hydrants and sprinklers. The fire pumps are in the Fire Pump House adjoining the Boiler House, with an independent steam supply from the main steam header above the boilers, while the sprinkler tank is on the top of the elevator tower adjoining the Wood Pulp Warehouses.

The Chemical and Physical Laboratories are on the ground floor of the Office Building. The equipment is most complete and up to date, affording not only a regular examination of the whole range of raw materials, chemicals, fuels and general supplies, but unusual facilities in a "laboratory" paper mill.



FILTERS FOR RECOVERY OF STOCK FROM EFFLUENT.
Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

SPANISH RIVER PULP AND PAPER CO., LTD., ESPANOLA, ONTARIO, CANADA.

The mill is on the Spanish River, 22 miles from its mouth, and also on a branch of the Canadian Pacific Ry., 120 miles from Sault Ste. Marie. A tract of 6,000 sq. miles of generally timbered country is tributary to it, from which it has been estimated that a sufficient amount of spruce wood is available by river driving to last 50 years.

The present installation consists of a hydraulic development having a net capacity of 10,500 h.p. and a pulp mill with an actual daily production of 150 tons. While the works and buildings of this initial installation are for the production of ground wood pulp only, they were designed in such manner that extensions for the manufacture of paper and sulphite pulp may be made without serious interference with the operation of the mill.

Water Power.—The watershed of the Spanish River and its tributaries extends from the Height of Land to Lake Huron and is one of the two largest drainage areas tributary to that lake on the north, covering approximately 4,500 sq. miles. As this region has not been sufficiently surveyed, much is left to be inferred in regard to its exact area and character.

A flow of 2,750 cu. ft. per second can be maintained by a moderate expenditure for storage dams on the headwaters of the streams. Such a flow would result in a permanent 24-hr. power of 15,000 h.p., net, on the wheel shafts, with a 60-ft. head and 80 per cent. efficiency, and this is the amount of power provided for by the plans for the original plant.

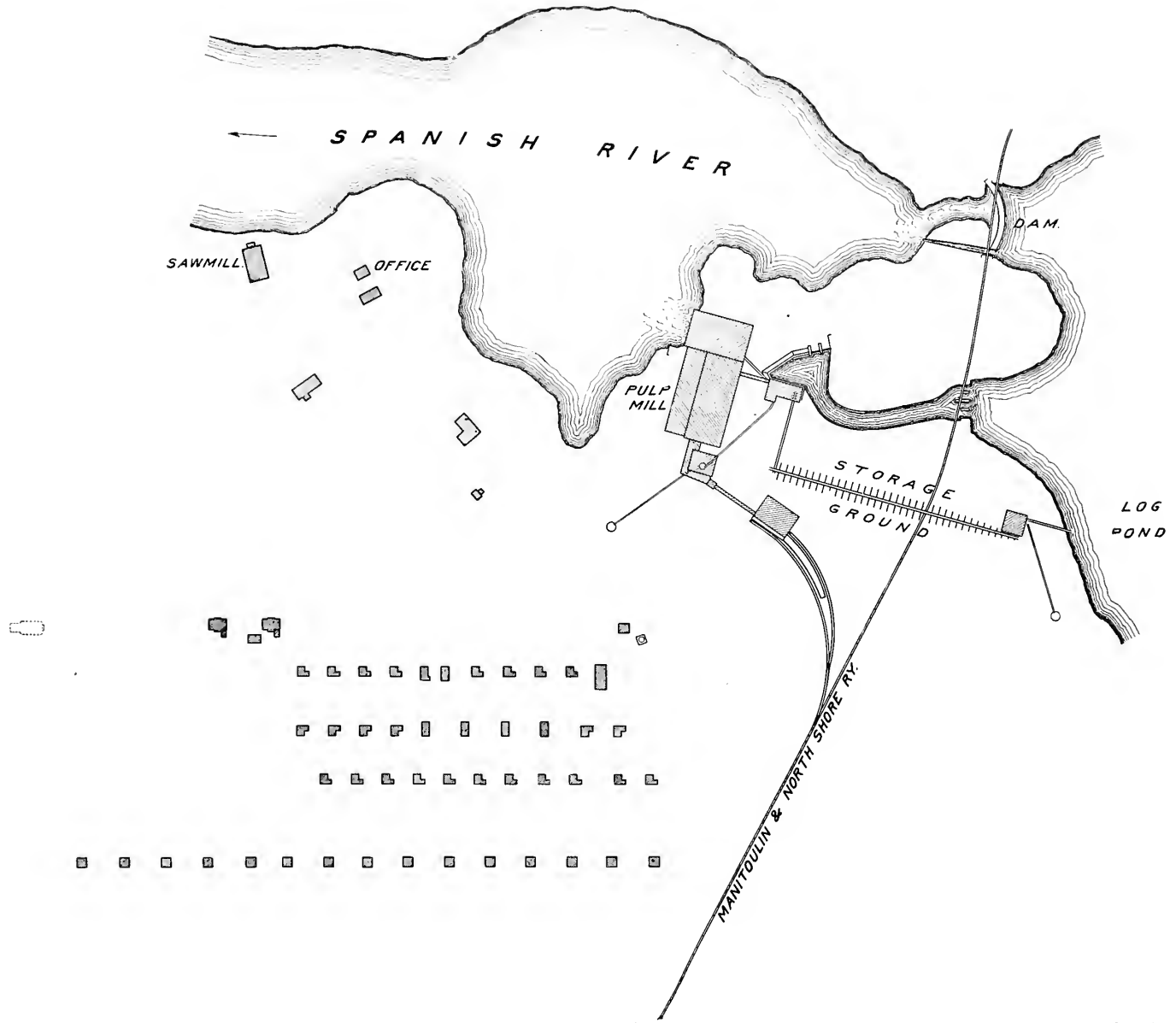
A falls, consisting of a main sheer leap of 24½ ft., with rapids above and below this leap, giving an aggregate total drop of 28 ft., existed at the site before construction was begun. This fall was over granite rock in a narrow gorge, which was a great advantage to the completed structure, but which presented much difficulty during the construction work.

The dam raises the water level 32 ft. at the lowest stage of the river. It has a cross-section of the Ogee type, with the upstream face in slightly battered steps, and in plan is arched upstream like the arc of a circle, having a radius of 187 ft., the long chord of the arc being 200 ft. The dam raises the water so as to develop a total head of 60 ft., the reservoir formed by it overflowing land 5 to 6 miles upstream. The arched type of structure was adopted to provide an additional spillway for flood flows as well as to secure anchorage to the solid rock abutments at each end of it. The hydraulic works above the dam were designed for a raise of 10 ft. of water over the crest of the latter.

A canal, with its headworks about 300 ft. from the south end of the dam, was cut through the high ground between the reservoir and the mill, with a total length of about 400 ft. This canal terminates in a forebay, from which water is delivered to the wheels by penstocks. It was excavated partly in rock and partly in clay soil, the entire side next to the river being on a rock foundation, while the other side is

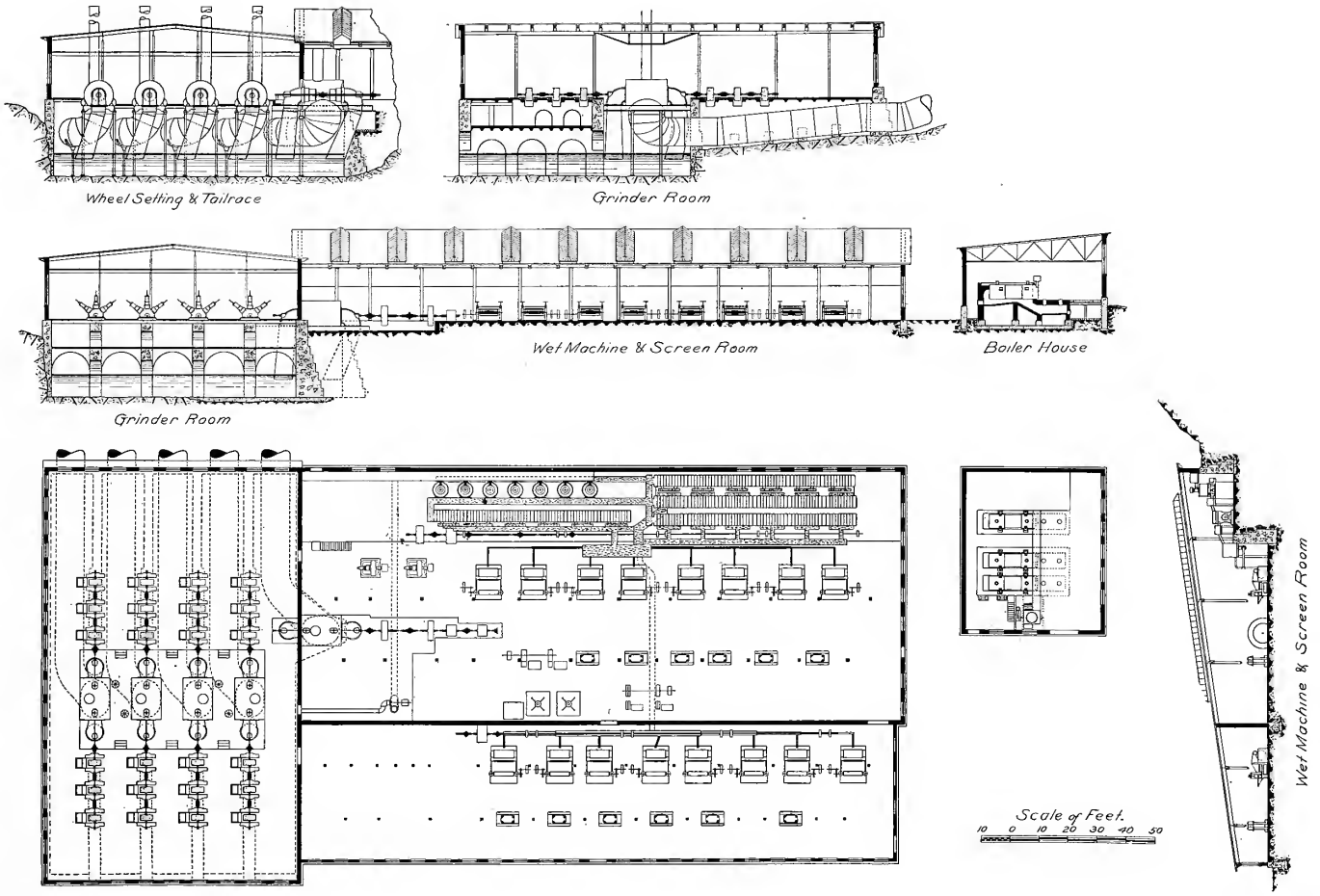
GENERAL VIEW.

Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.



GENERAL PLAN.

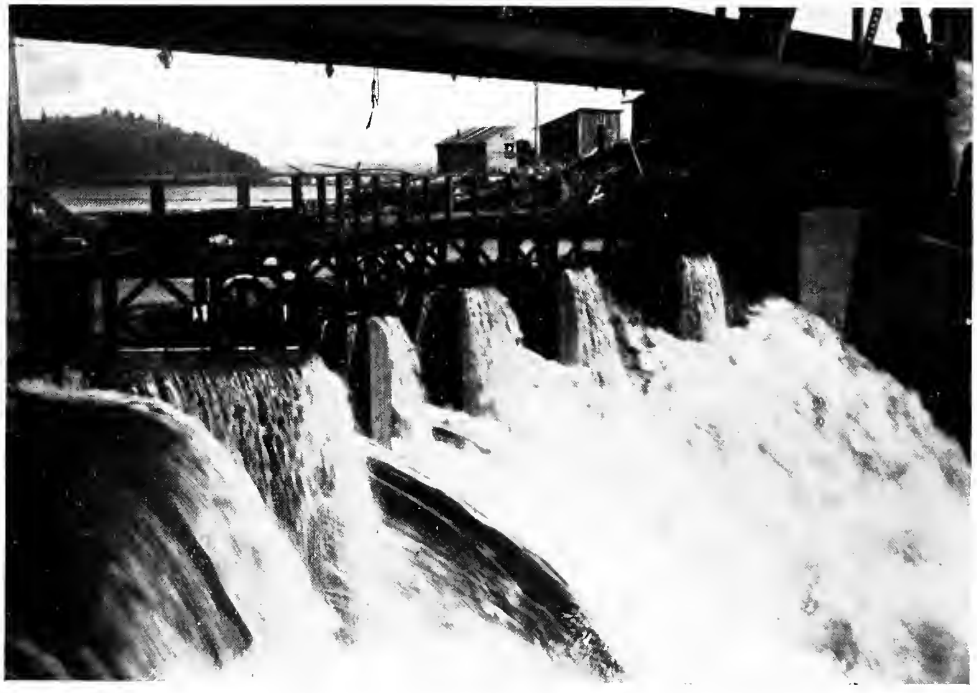
Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.



PLAN AND SECTIONS.

Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.

UNDEVELOPED FALLS AND COMPLETED DAM.
Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.



FRESHET CONDITIONS.

Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.

sloped back inland in the soil and is well riprapped to avoid scour. The character of the ledge was such that the amount of excavation taken from the canal was governed by the quantity of sand and rock required for the concrete necessary to build the dam and the foundations of the various structures. Clay from which all brick was made was also obtained from the canal excavation. The cross-section of the canal was to be 45 ft. wide on the bottom, with a vertical face in the rock on the river side and a 1½ : 1 slope in the clay, the depth of water being 12 ft. The canal was not finished in accordance with the plans, however, and will require some further excavation when the ultimate development is made. At the entrance of the canal suitable gates are provided for drawing the water from it in case of emergency.

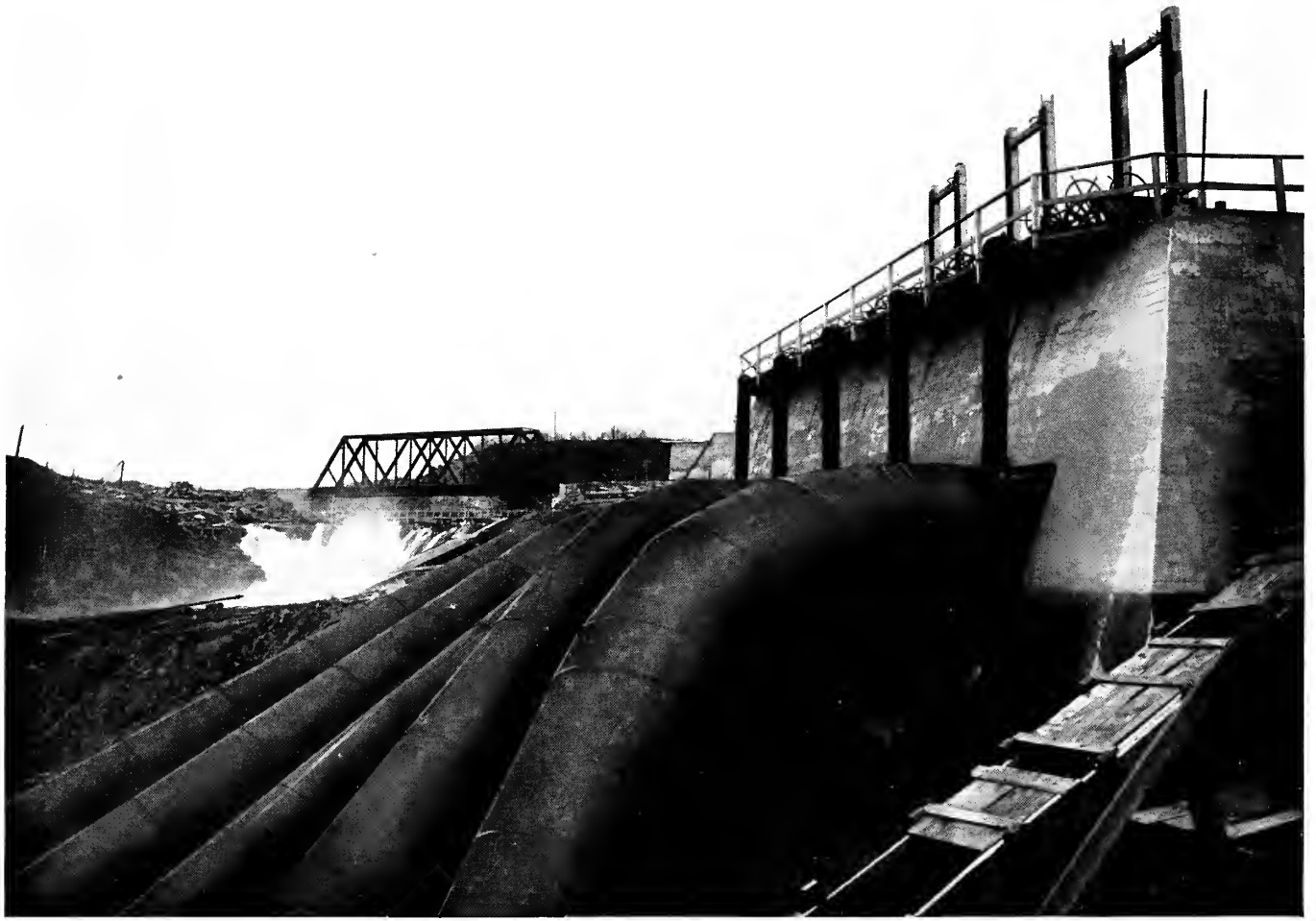
The forebay at the end of the canal is formed by a concrete wall containing the various openings for flood discharge and for penstocks. Two flood discharge openings are placed at one end of this wall, each 20 ft. wide and controlled by stop logs. Considerable quantities of saw-logs are driven down the river, in addition to the logs used in this mill, but are diverted from the canal by a log boom and are passed over a sluice built at one end of the dam. At the other end of the forebay wall from the discharge openings are six openings for penstocks leading to the water wheels. Five steel penstocks have been installed each 10 ft. in diameter and a sixth will be added when the proposed extension is made. Each penstock is controlled by hand-operated gates placed in the forebay wall.

The installation of water wheels consists of five pairs of 39-in. horizontal turbines of about 2,100 h.p. each, with provision for a sixth pair of the same capacity.

The general plan of the development and mill shows the existing structures as cross-hatched, while the proposed extensions are shown by dotted lines. The site is fairly level from the edge of the log pond, almost to the upper end of the main building of the mill, thus providing considerable space for the storage of wood. The wood-preparing building is at the downstream edge of this level space.

The raising of the level of the stream about 32 ft. by the construction of the dam overflowed a large tract of low land, forming an excellent log pond, with a capacity of about 20,000 cords of wood. In front of this pond there is suitable booming ground for the separation of the logs for the mill from those intended for operators below. This large storage capacity is especially valuable, because the open water season in the river is about seven months only, so that it is economical to saw and pile the entire year's cut in 2-ft. lengths during this short season.

A 30 x 30-ft. building about 50 ft. from the edge of the pond contains the sawing rig, and the logs are delivered by means of a chain jack ladder. This



HEADGATES AND PENSTOCKS. Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.

chain is controlled by one man, who also operates a kicker at the end of the chain that delivers the logs to an alligator-chain table and lines up the logs so that their head ends follow a regular line to the saws. The logs are cut in the woods approximately the right length and are trimmed to an exact length of 16 ft., plus a slight allowance for sawdust loss in the cuts that are made afterwards. The logs are then cut into 2-ft. lengths by saws in parallel. Alligator chains are used throughout this operation, the logs being literally dragged through the revolving saws. Freedom from friction at the saws is obtained by means of a vertical knife-edge spreader fixed behind each saw, by means of which spreader the pieces are separated about 2 in. immediately after leaving the saws, the chains sliding transversely on the structural channels which support them. The 60-in. slasher saws installed are driven by a 120-h.p. motor. The dust produced by the saws is blown through a 10-in. pipe to a pile near the river, where it is burned. This saw plant is at present driven electrically with power generated in the mill, as under the existing conditions there is power to spare. Whenever the demand for power in the mill becomes great enough, however, to require the amount available, a steam plant supplied with power from boilers fired with refuse sawdust will be installed.

A wooden pole trestle, 65 ft. high and 600 ft. long, extends across the storage space from the saw house toward the wood-preparing building.

Under the trestle is space for storage of 60,000 cords of wood, an amount sufficient to operate the mill through the closed season.

The 2-ft. lengths of wood are reclaimed from the storage pile by reversing the conveyor which delivers them to that pile.

Eleven men can easily handle the entire wood-handling operation, taking from the water, sawing and piling in the storage space 5,000 to 6,000 logs in ten hours of operation. In fact, the apparatus is so well adapted to the work for which it was provided that handling, sawing and piling of logs in 2-ft. lengths are done at a total cost for labor and all expenses of less than ten cents per cord.

The barked logs are dropped through a chute into a tank in the grinder room.

The main buildings of the present mill consist of a grinder room, a machine room, and a temporary building. The location of the grinder room was governed largely by the water-power development, while the position of the remainder of the equipment of the mill depended largely upon the arrangement of the apparatus in that room.

The grinder room is 90 x 146 ft. in plan and contains four pairs of special horizontal turbines, each pair of turbines being direct-connected to six three-pocket wood-grinding machines. These machines are arranged three on either side of the pair of wheels. This arrangement appeared to be most desirable in view of the high speed and power developed by the ordinary turbines at 60-ft. head.

WOOD SAWING PLANT.

Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.

A traveling crane of short span has also been installed to command each set of twelve grinding machines, so that grinders, stones and shafting in all parts of the room can be handled by these cranes.

The division walls of the tail-races are placed directly under the grinder shafts, so that an absolutely rigid foundation is secured, which reduces the liability to accident and repairs and also cuts down materially the cost of floor construction. In fact, the operation of the mill for the first two years has shown a total repair account for the grinder room and water-power development of less than $200. No repairs have been made except on Sundays, as the grinders have operated 24 hours a day, six days a week, during that period without a breakdown.

The machine room is 90 ft. wide by 211 ft. long and contains the fifth pair of turbines, which discharge into a tail-race under the grinder room. This pair of turbines is placed at right angles to the grinder wheels and provides power for screens, wet machines, pumps for stock and water, a rotary fire pump and all the electrical apparatus for power and lighting the mill and village.

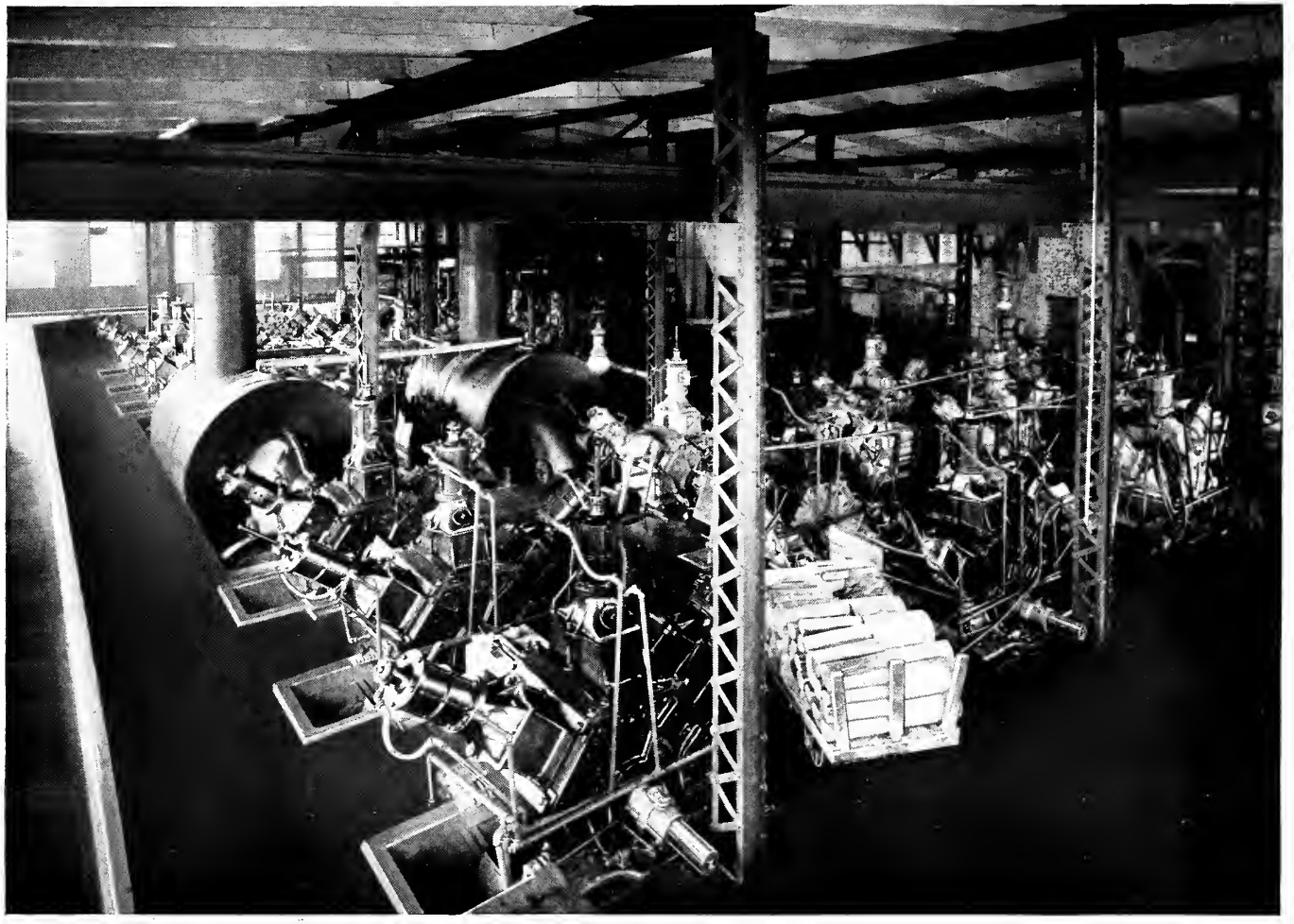
In a gallery of the machine room are 36 ten-plate screens of the diaphragm type and a pair of centrifugal screens for tailings from these diaphragm screens. Stock is delivered to the latter from the storage tank under the grinder room by a centrifugal pump. The stock passes through the wet machines and is delivered from them in sheets which contain about 70 per cent. water. The trucks are then placed in hydraulic presses, and the moisture reduced to about 35 per cent. water by heavy pressure.

The loaded trucks of pressed pulp are hauled from the hydraulic presses to the foot of an elevator outside of the machine room, at the edge of the hill back of the mill building, and are raised to the level of the higher ground upstream from the building. At this level a runway extends to a shipping room, with connections to the railroad. It is also possible to have a cableway conveyor to load directly to boats at a landing at the river, or a spur track may be built to the wharf and the shipping room.

The buildings of the mill are heated by steam from three 60-in. by 18-ft. tubular boilers, fired by the shavings delivered to them from the wood-preparing building. The excess of these shavings is carried to a pile outside of the limits of the buildings and burned.

As the mill was isolated, it was necessary to erect houses for the operatives and others connected with it. The various buildings have connections with a water-works system and are lighted by electricity furnished from the mill.

The chief feature of the construction work was the building of the dam across the narrow gorge from which a large volume of water had to be diverted. After several futile attempts had been



GRINDER ROOM (24 GRINDERS).

Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.

made to erect a cofferdam which would have sufficient stability to raise the water level of the pond on the upstream side of it high enough to divert the flow through the canal, and at the same time be tight enough to un-water the site of the dam so that work could be handled with a reasonable amount of pumping, the contract was abandoned. The work was then taken up by force account under the direction of the engineers.

As the minimum low-water season occurs between December 15 and March 15 of each winter, the decision was made to undertake the construction of the dam during this season, notwithstanding the fact that the temperature frequently reaches 40 deg. below zero, and for long periods rarely rises above zero.

As soon as the dam site was un-watered the excellent trap rock foundation of the dam was thoroughly cleared of an overlying stratum of clay and soil and the concrete work started. The rock and sand excavated from the canal were of especially good character for concrete. Two 1-yd. cubical concrete mixers were set up, one in a mixing plant at each end of the dam, in a position which would enable them to discharge into skips that were hauled on flat cars on an industrial track extending from the mixing plant to within the range of guyed derricks used in handling the materials for the construction of the dam. As all of the concrete was laid in the coldest of weather, the sand and water used in it were heated to a temperature of about 90 degrees Fahrenheit by means of live steam supplied by the boiler of the mixing plant. The concrete was delivered to place in the dam as rapidly as possible after leaving the mixer, and was then thoroughly protected against frost, so that the temperature of the concrete when placed was about 50 deg. Fahr. Work was started at both ends of the dam simultaneously, the sections of which were carried up with irregular surfaces and faces to prevent the formation of horizontal or vertical planes of cleavage, since a small section of the dam was not closed until later, in order that such water as leaked through the cofferdam could be readily carried across the site. The junction between the various sections was also made by means of large stone imbedded in the concrete, the latter being made in the proportions of 1 part cement, 3 parts sand and 5 parts broken stone, with the large stone imbedded in it. These stone in no case form more than 30 per cent. of the total volume. Operations were carried on continuously 22 hours out of every 24 from the time the concrete work was started, about February 1, until it was completed, about March 15, although during this time temperatures as low as 40 degrees below zero were recorded and cold weather prevailed all the time.

Since the completion of the dam it is evident that the concrete has in no case suffered from the effects of freezing.

SCREEN AND WET MACHINE ROOM.

Spanish River Pulp and Paper Company, Espanola, Ontario, Canada.

M. J. WHITTALL CARPET MILLS, WORCESTER, MASS.

The Spinning and Carpet Weaving Mills of M. J. Whittall are located in Worcester, Massachusetts, on the banks of a little stream furnishing a small amount of power and an abundance of water for steam boilers and condensing engines.

The establishment is the result of a gradual growth of a spinning and weaving industry and from time to time demanded additions to its power equipment, which became scattered through the property, and numbered three separate and distinct boiler and engine plants.

When the mills were still further increased by the addition of a large dye house, the consolidating of these three plants into one central station became of much importance, and the substitution of electrical for the mechanical transmission of power from the widely separated engine plants, not only saved considerable power, but effected an economy by the use of a large generating unit in place of the three smaller ones.

A modern type of electric power station was erected on a spot centrally located with reference to power transmission and adjacent to a new dye house also erected at the same time, and which uses large quantities of steam furnished from the new power station.

Cooling water being abundant, the compound condensing type of engine was selected, and as it was of a quality suitable to be used in the dyeing process, advantage was taken of the heat which the condensing engine gave it by using it in the dyeing vats after it had passed the engine condenser.

The system of electrical transmission adopted was the three phase alternating current with a potential of 440 volts. Induction motors of the "squirrel cage" type were used. With this form of motor, all liability of electric sparks between stationary and moving parts of motors was eliminated and greatly reduced the hazard from fire that other systems might have introduced into rooms where the lint and dust that accumulates is of such an inflammable nature.

The power house comprises two rooms, the engine room and the boiler room. In the engine room is a horizontal, cross compound condensing engine direct connected to an 800 K. W. alternating current generator. There is also a motor driven exciter and an engine driven exciter for exciting the revolving fields of the 800 K. W. generator and a switchboard that controls the main and exciting generators and the curcuits feeding the mills.

In the basement of the room are a condenser and air pump, an air compressor, a pressure oiling system, an oil separator for extracting the grease from the exhaust steam when under vacuum, and a motor driven centrifugal pump for lifting the cooling water from the condenser to storage tanks in the dye-house.

This motor driven pump is started and stopped automatically by a float controlled starter located

POWER PLANT.

M. J. Whittall, Worcester, Mass.

near the water storage tanks in the dye house some distance away from the pump.

The switchboard on the main floor of the engine room is completely equipped with indicating and recording instruments as well as switches for the control of the electric system.

An interesting feature in the electric system is the utilization of the small water-power. The water wheel is used to drive a 75 K. W. generator that is located several hundred feet away from the main generating station. This small generator is, however, arranged to be run with the large engine driven generator, and means for bringing it to proper speed for synchronizing is provided at the main switchboard. A system of push buttons controls a motor attached to the Lombard water wheel governor, thus regulating the speed. In this way, the energy from the water power is distributed into the general power system and can always be used to its full capacity.

The boiler plant is comprised of water tube boilers, fuel economizers, and duplex boiler feed pumps. Draft is procured by a radial brick chimney.

One end of the boiler house is devoted to the installation of the economizer, which is placed in an elevated position, thus leaving floor space beneath it, which is separated into three rooms. These are used for oil storage, toilet, and fire pump rooms, each being separated from the other by brick partitions.

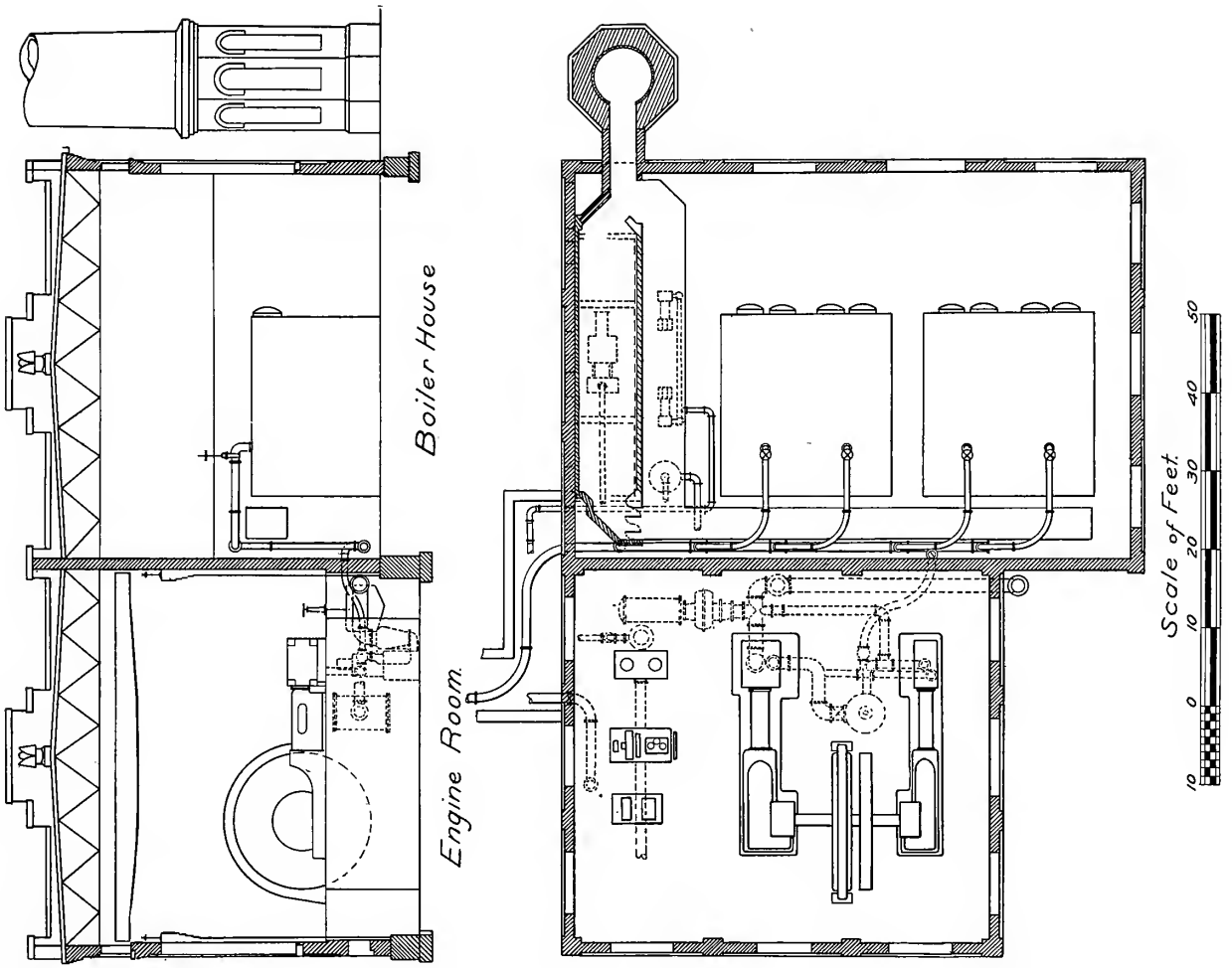
Alongside the economizer is a reserve flue leading directly from the boilers to the chimney and under this flue are placed the boiler feed pumps.

Between the boiler house and the dye house is an underground passage through which is taken steam and water pipes and electric cables. At the floor level of this passage is placed a receiver for the collection of all the high pressure condensation which accumulates in the steam pipes. From this receiver the hot water is returned to the boilers without the aid of pumps by means of a gravity return system, which is entirely automatic in its action.

The high pressure steam piping is arranged with large wrought steel bends to compensate for expansion and contraction, and is thoroughly lagged with magnesia to prevent condensation.

The handling of ashes is facilitated by the erection of a large storage hopper adjacent to the boiler house into which ashes are raised by means of an elevator, and from which they are drawn periodically into carts and conveniently disposed of.

Although not large, the entire plant is provided with the most approved equipment for the generation of both steam and electric power, and is representative of its type.

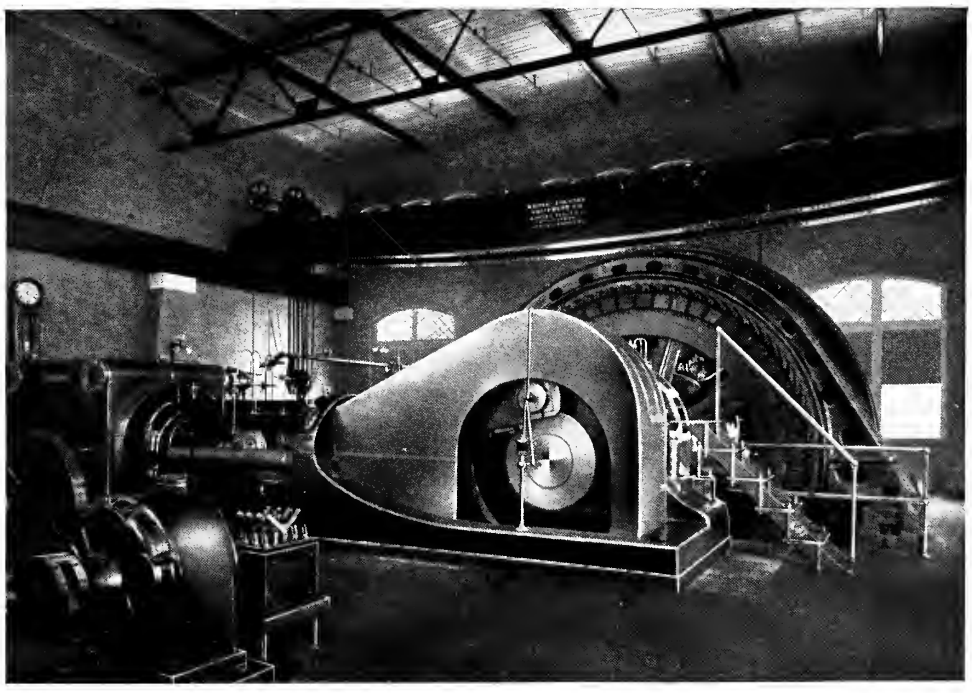


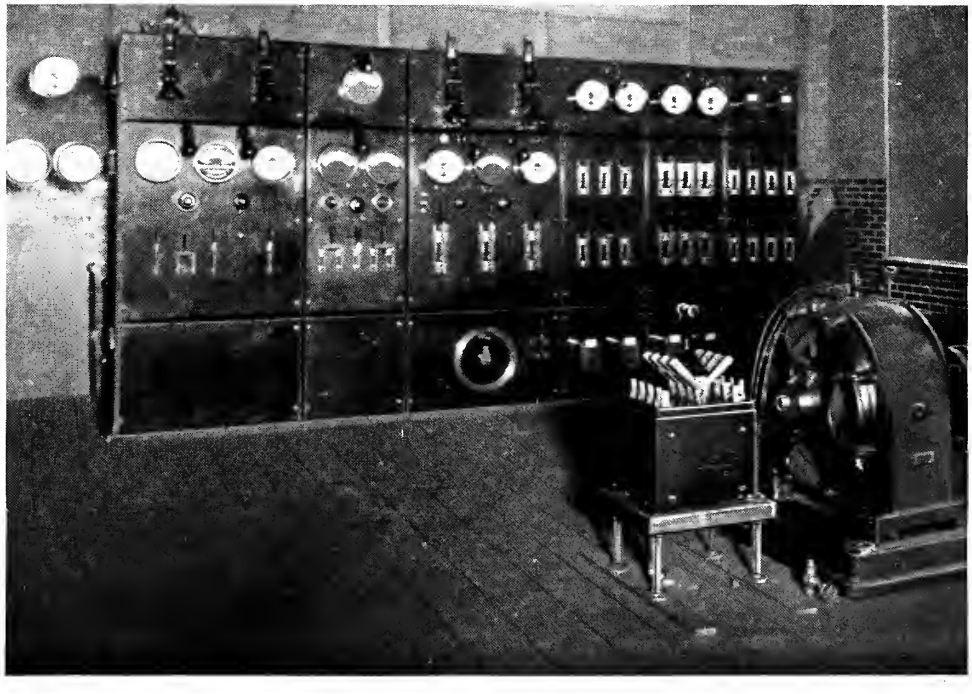
PLAN AND SECTION OF POWER PLANT.

M. J. Whittall, Worcester, Mass.

BATTERY OF B. & W. BOILERS.

M. J. Whittall, Worcester, Mass.





GENERATOR ROOM.

M. J. Whittall, Worcester, Mass.

ASHUELOT PAPER COMPANY, HINSDALE, N. H.

The plant of the Ashuelot Paper Company is a good example of a modern, one-machine, tissue mill, arranged to provide for the future installation of an additional machine.

This Company was composed of several parties already interested in tissue manufacture. The plant shows what can often be done with a small investment.

The site secured, on the Ashuelot River, was the location of a water power privilege and of a mill that had been burned and abandoned. The headwater was raised by an addition to the existing dam and a large increase in head was obtained by means of a long penstock and locating the mill at the lower end of the privilege, thus taking advantage of the rapids below the dam.

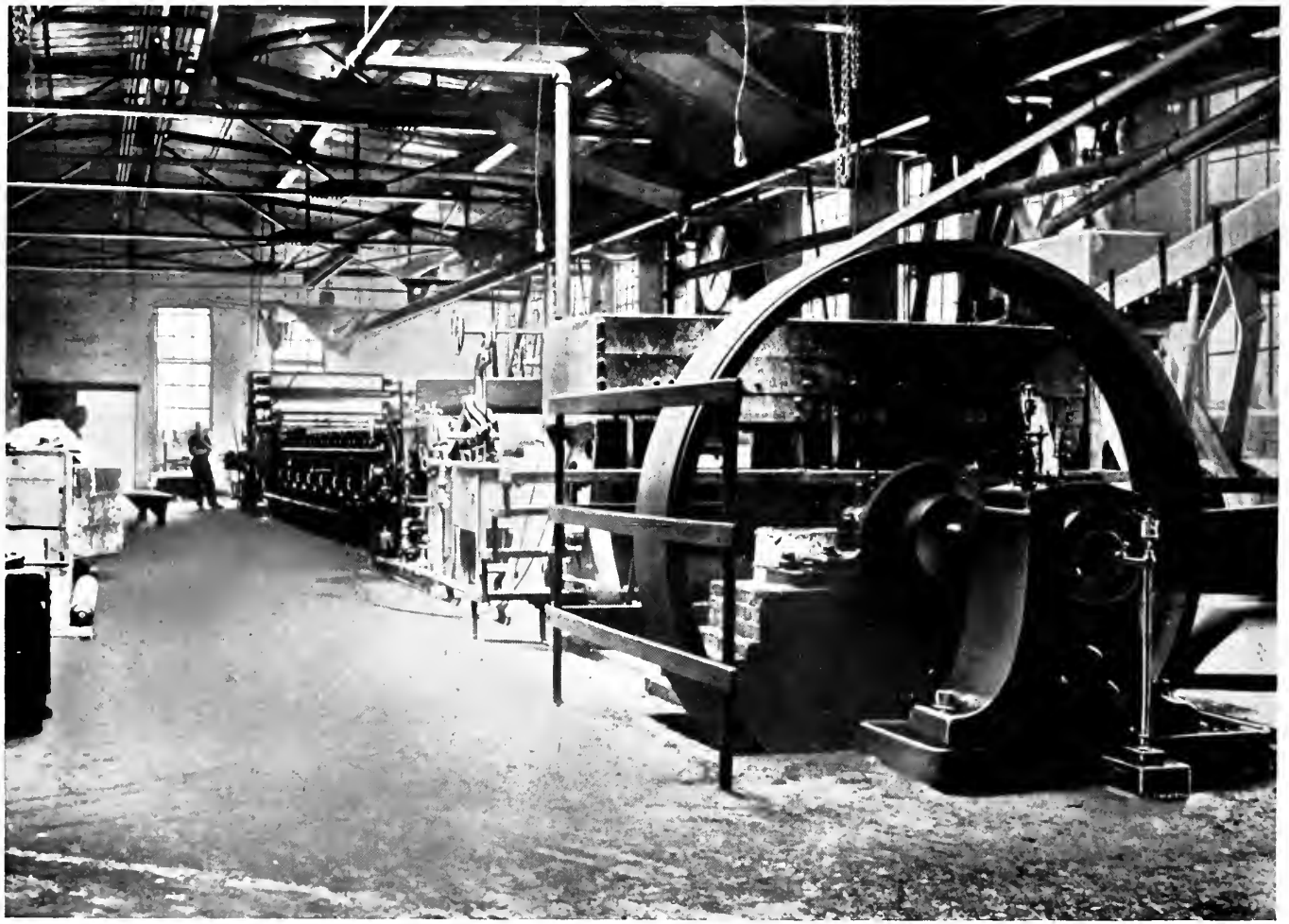
The side hill location with short siding along the upper level gave an opportunity to carry the main building above the beating engines and provide stock storage and preparing department as well as temporary finishing and shipping room on the level of the cars on the railroad siding. The machine room is of one story, and the foundations were made by simply clearing the ledge underlying the entire site.

The steam plant (boiler and engine rooms) was placed in the corner adjacent to beating engine basement and machine room; and the side hill was utilized for the coal chute and storage, making the handling to the boilers most convenient.

The plant depends on water power for all except paper machine drives, but has a relay steam unit for driving beating engines when low water occurs. The wheel installation consists of a continuation of the penstocks with turbines mounted in pairs, and is entirely outside the buildings. The tail-race is protected by a river wall, which also supports the wheel cases and penstocks.

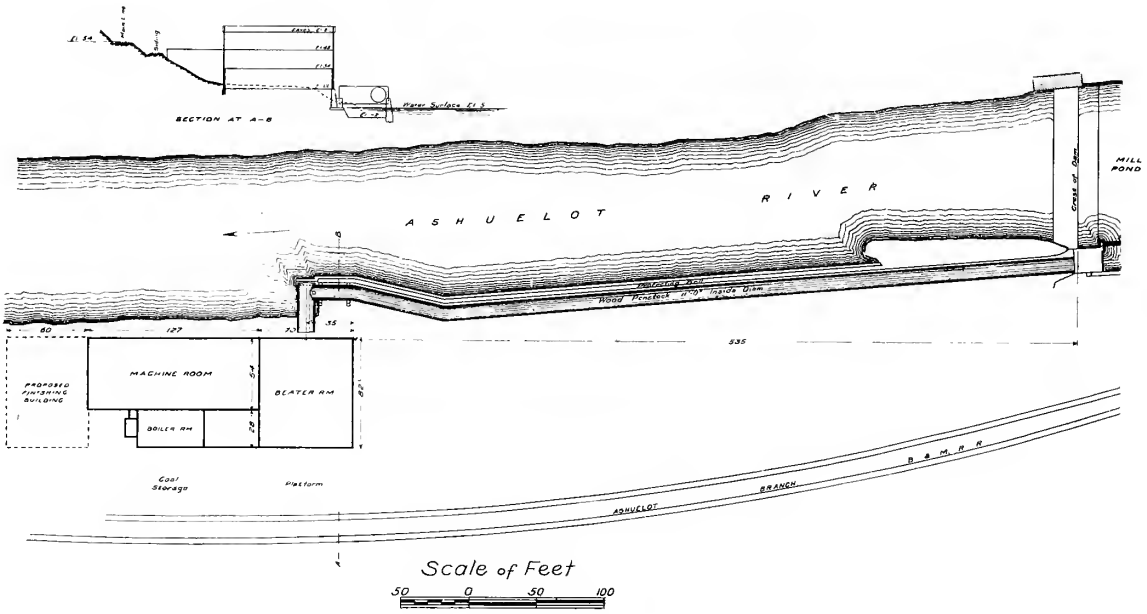
The plant is of the slow burning mill construction approved by the mutual insurance companies and is not expensive, yet has every requisite for manufacturing to advantage the particular specialties of the company, namely, light stock papers ranging from toilet to railway copying and pattern.

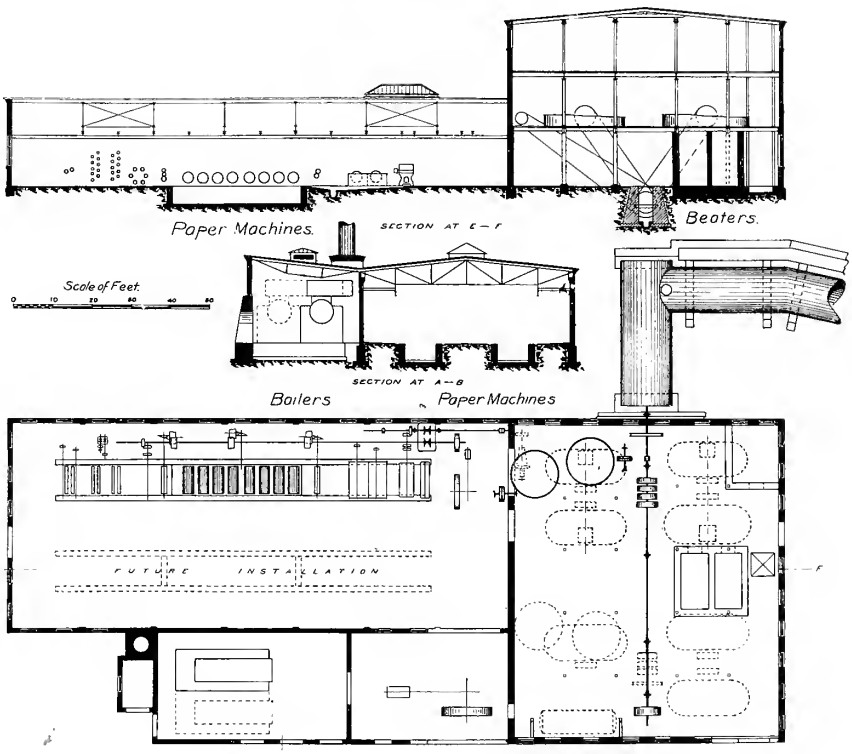
ASHUELOT PAPER COMPANY, HINSDALE, N. H.



MACHINE ROOM—FROM WET END.

Ashuelot Paper Company, Hinsdale, N. H.





PLANS AND SECTIONS.

Ashuelot Paper Company, Hinsdale, N. H.

ROANOKE RAPIDS POWER COMPANY, ROANOKE RAPIDS, N. C.

The hydro-electric power development for the Roanoke Rapids Power Co., at Roanoke Rapids, N. C., was undertaken during the month of July, 1906, and consists of a concrete dam across the Roanoke River, additions and extensions to several small hydraulic structures that had been previously erected, two sets of headgates, the installation of a penstock, 12 feet diameter and about 750 feet long, the enlargement of the power canal, and the construction and equipment of a hydro-electric power plant.

The installation prior to 1906 included several low dams, a forebay, set of headgates and a power canal. The improvements necessitated additions to these structures both for stability and for controlling the water, due to the increased head necessary to maintain under the new conditions.

The company can now deliver about 7500 H. P., about one-half of which is now being used by industries at lower end of canal, among them a mill for the manufacture of chemical pulp from native pine and a paper mill in conjunction with the above mentioned pulp mill, including a mechanical ground wood pulp plant (see Roanoke Rapids Paper Mfg. Co. article), a mill producing print cotton goods and cotton flannels, and a mechanical pulp mill. These plants obtain the water for power direct from the canal.

The hydro-electric power plant will furnish power for lighting purposes, machine shops, and for additional industries and extensions to those in existence.

Considerable difficulty was experienced in the construction of the concrete dam, which is nearly 4000 feet long and 4 to 8 feet in height, owing to the immense volume of water after heavy rains, the rise coming suddenly upon the work.

The site for the dam was selected with a view to secure a solid ledge foundation throughout at the least expense for construction, and, at the same time, to secure sufficient area at the back of the dam for the flow of the stream.

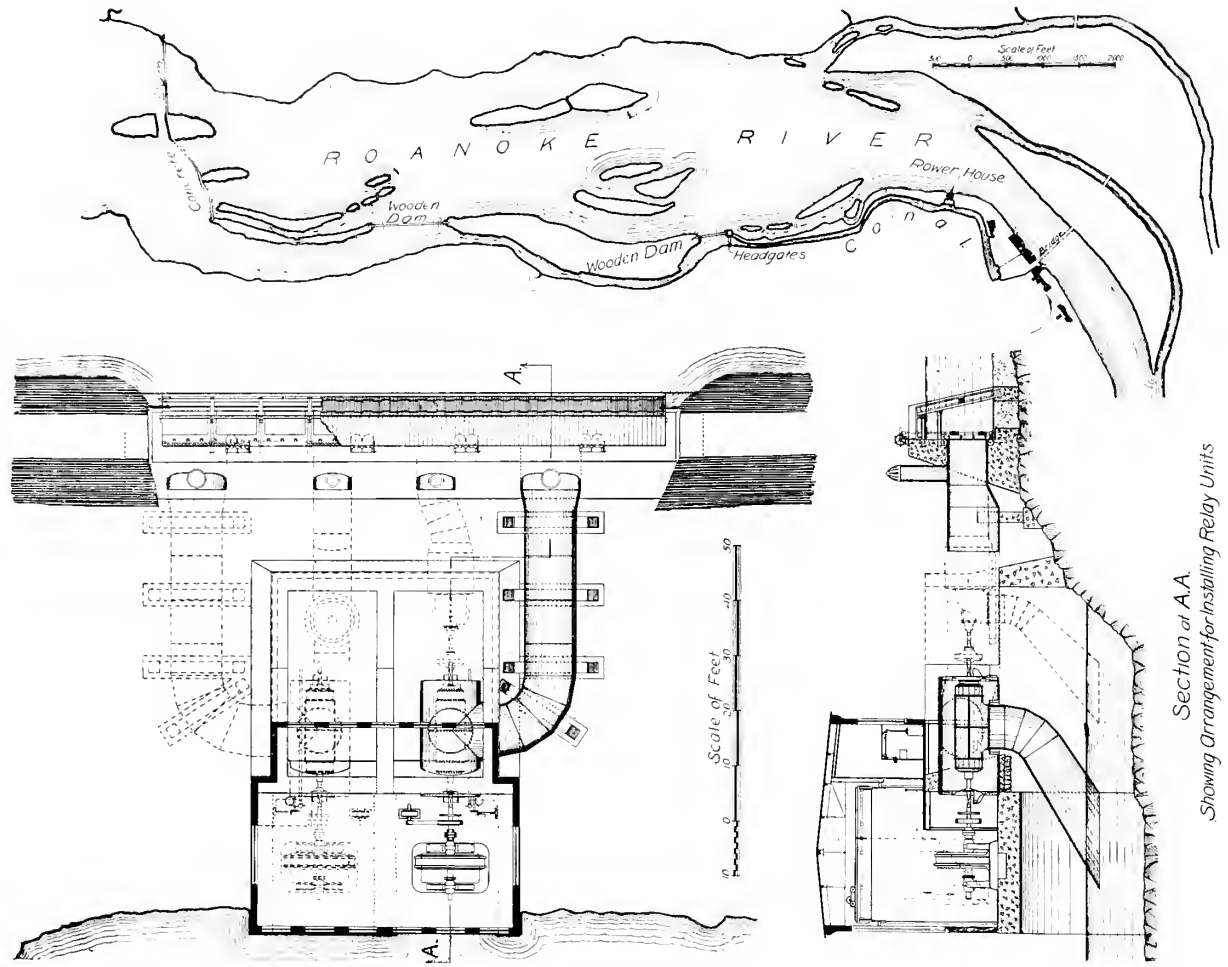
Many of the numerous islands in the river were used as a part of the dam, wherever they were of ledge formation, so that while the dam is about 4,000 feet long, the concrete dam proper is 3,300 feet long, not including islands. It contains only 2,600 cubic yards of concrete, or ¾ cubic yard contents to foot length.

The diverted water flows to a natural forebay about 1¼ miles long, at the lower end of which there is a set of 12 lifting gates located in a stone bulkhead. This forebay is formed of islands and wooden crib dams put in as a part of the earlier development. The total length of the wooden dams is about 2,000 feet (one 600 feet and one 1400 feet). These dams were raised 3½ feet and made secure.

The canal proper is about one mile long. About ¾ mile below the gates the hydro-electric power plant is located. Four sliding headgates located in a concrete bulkhead control the water used for

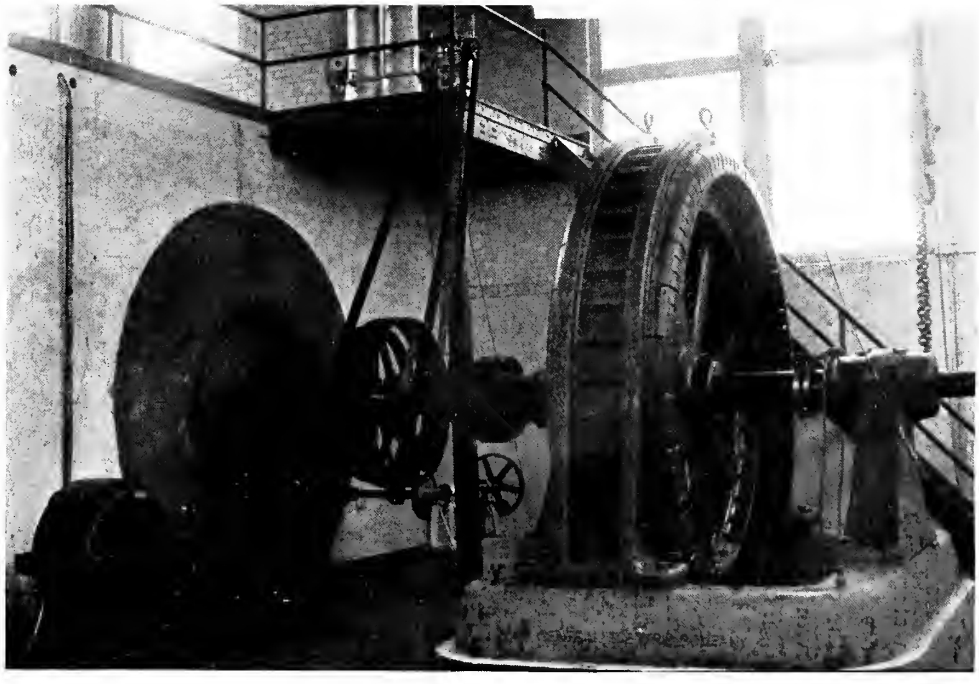
HEADGATES AND POWER STATION.

Roanoke Rapids Power Company, Roanoke Rapids, N. C.



GENERAL PLAN AND LAYOUT.

Roanoke Rapids Power Company, Roanoke Rapids, N. C.



POWER ROOM.

Roanoke Rapids Power Company, Roanoke Rapids, N. C.

operating this plant. The water is diverted to the water wheels from the canal through steel penstocks, and then into the river, the distance from the canal to the river being less than 100 feet. The working head is 30 feet.

The foundations of the Power House are entirely of Portland cement concrete and rest upon solid ledge throughout. The superstructure is of red brick, with wooden roof covered with tar and gravel roofing, the roof being supported by steel roof trusses.

The floors are of concrete and steel, upon which is laid a hard wood top flooring.

The general arrangement can be seen on plan. The first installation consists of one pair of 39" McCormick turbines in a steel case mounted on horizontal shaft to which is direct connected a 750 K. W. alternating current generator.

Upon a gallery in the generator room is located the switchboard and all other devices for the operation of the plant. An overhead traveling crane is provided for handling the generators.

Provision has been made for the future installation of a duplicate of the present equipment, also for the addition of an auxiliary turbine in direct connection with each unit if required. The auxiliary plant will be used only during periods of extreme high water, when there is a material loss of head by backing up of tail water.

It is possible that the developments of future power units will be in the nature of additional units instead of auxiliary ones to supplement the first units during freshet periods, because these periods have proved to be rare and of short duration. The first installation permits extension along either line found desirable and permits a possibility of 2 units of 750 K. W. and 2 units of 500 K. W. respectively. The ultimate capacity of the plant will be 2,500 K. W.

CONSTRUCTION DETAIL.

Roanoke Rapids Power Company, Roanoke Rapids, N. C.

THE MUNISING PAPER COMPANY, LTD., MUNISING, MICH.

Munising, Mich., has grown largely through the activity of the Cleveland Cliffs Iron Company. Lands taken primarily for charcoal woods have shown spruce, pine, hemlock, balsam, tamarack, cedar, and other valuable woods, which are now being manufactured into lumber, shingles, telegraph poles, and other wood products, and the hemlock bark is being used in one of the largest tanneries in the world. The Munising Paper Company's extensive plant is another link in the chain of developments of this company.

Munising harbor, on Lake Superior, offers excellent lake shipping facilities and unexcelled water for manufacturing use. The Munising Railway, another Cleveland Cliffs Iron Company organization, connects the village with all the principal railway lines of this section.

The raw material for the proposed grades of papers is plentiful and excellent in quality, and labor conditions are satisfactory. Coal and wood refuse are both obtained as fuel.

The plant of the paper company is in three groups of buildings: the sulphite fibre mill, the paper mill, and the power plant. The mill is an all steam plant, and electricity is the motive power of all sections. The mill buildings are arranged to provide for three digesters and three paper machines, and two units of each were first installed.

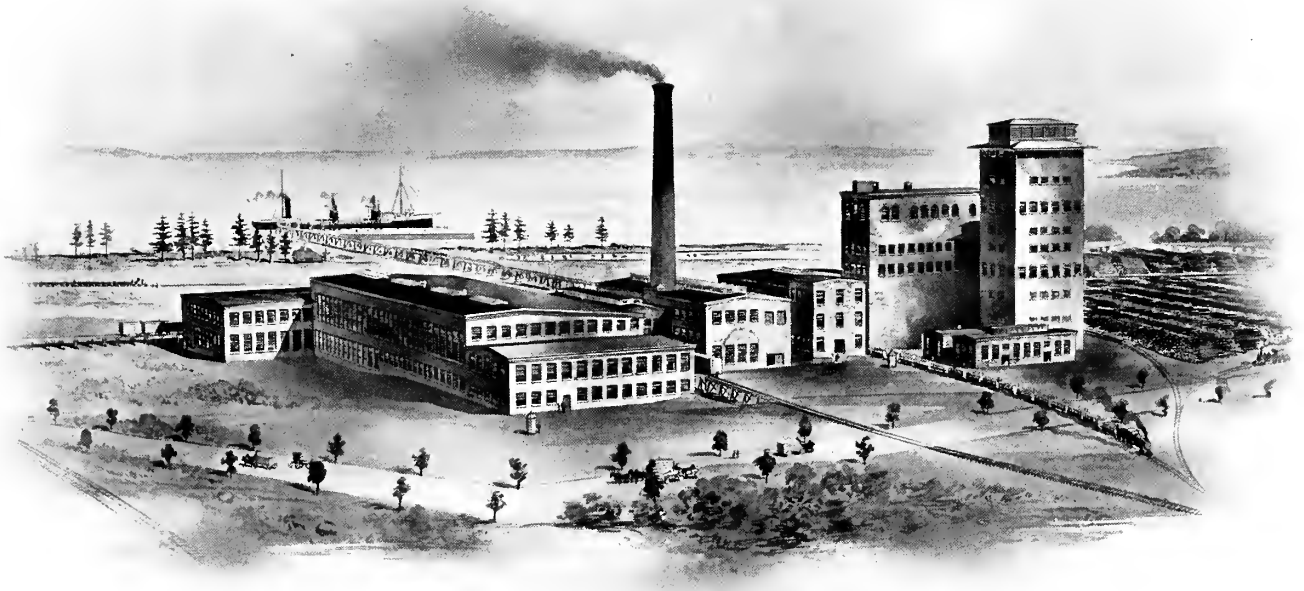
The sulphite mill is arranged for the manufacture of acid by the tower system, and to burn either sulphur or pyrites as may prove advisable, though the present plan is for sulphur burning. The digesters are fifteen feet in diameter by forty-seven feet in height, and produce twenty-five to thirty tons each per day. The location of the wood room enables a convenient handling of wood from the log storage pond, chips to the digesters, and refuse to the boilers.

The paper mill has two 136 inch machines, and provision has been made for another machine to be set up in the future. The power units are independent of each other, so that each machine and its beating and Jordan engines, chests, pumps, and other accessory machinery practically comprise a one-machine mill. The same division exists in all the piping and accessories, both in the paper mill and in the sulphite mill, a feature of great merit in the practical operation of the plant.

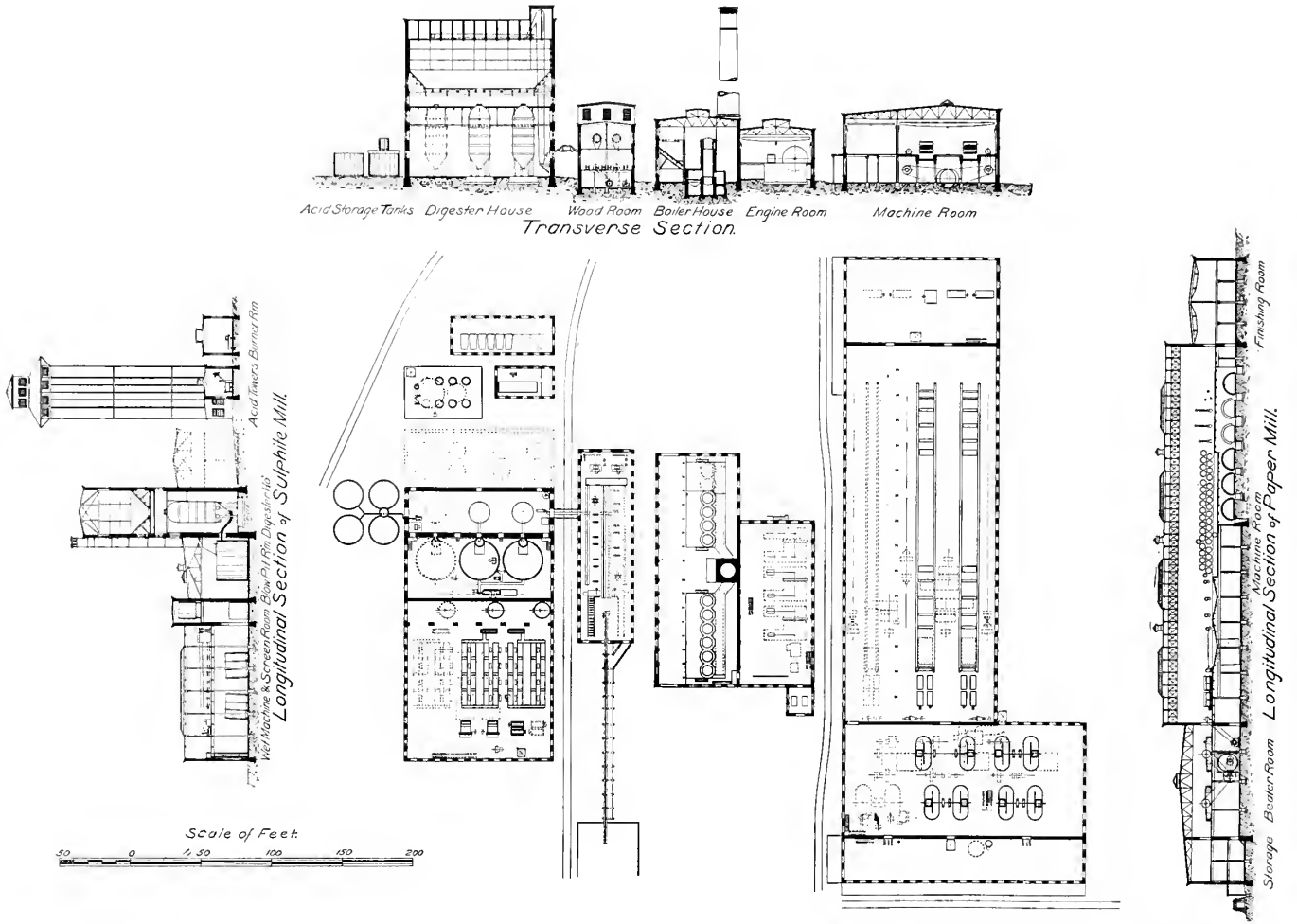
The water supply is secured by means of two motor-driven pumps, with a capacity of six million gallons per twenty-four hours. The intake is 200 feet out into the lake, insuring pure water at all times.

Fire protection service is provided in a complete hydrant system with two 1,000 gallon underwriter pumps in a separate building adjacent to the boiler house. Inside all buildings is a wet pipe sprinkler system, with a 50,000 gallon tank.

The power plant is a modern electrical power station, independent of all other parts of the plant and complete in every detail. Ten 300 H. P. boilers, with space for two additional, generate steam at 150

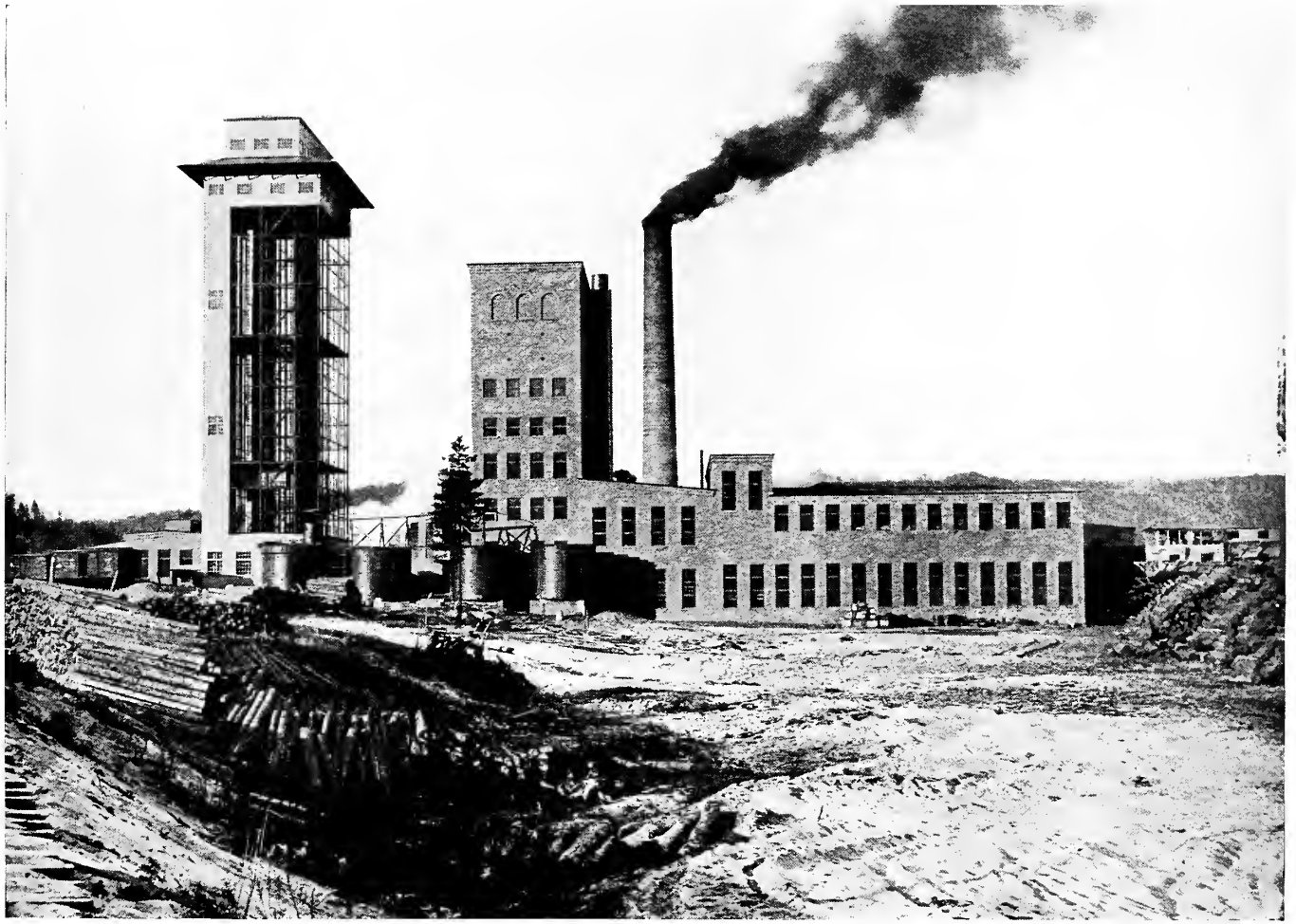


MUNISING PAPER COMPANY, LTD., MUNISING, MICHIGAN.



PLAN AND SECTIONS.

Munising Paper Company, Ltd., Munising, Michigan.



SULPHITE FIBRE MILL.

Munising Paper Company, Ltd., Munising, Michigan.

pounds pressure. The furnaces are designed to burn either wood refuse or coal under any boiler, by simply changing the grates. Each boiler has a heating surface of 3,068 square feet, with a grate surface of 98 square feet for wood burning, and of 56 square feet for coal. The arrangement of a hopper over the boilers permits gravity feed of fuel, either wood or coal.

The chimney is 11 feet by 175 feet, inside dimensions, and of radial perforated brick, with cast-iron cap. Two 20 by 40 by 42 inch engines and two 500 K. W. alternators, direct connected, with space for a third of the same dimensions are provided and a 50 K. W. alternator, Sunday unit, direct connected to a 11 by 12 inch simple engine, a steam exciter unit, and a motor-generator unit for direct current work for industrial railways, etc., about the plant.

The high pressure piping is tested to 225 pounds warm water pressure. Fittings on high pressure steam pipes 2 inches and above, and on water pipes 2½ inches and above, are "extra heavy." Fittings on exhaust steam pipes and low pressure water pipes 2½ inches and above are flanged and standard weight. Gaskets for steam pipes are corrugated copper. The valves above 3 inches have iron bodies with outside screw and yoke. Below 3 inches they are of composition. The high pressure valves above 6 inches are double seated, and provided with removable bronze seats and by-pass. All high-pressure drips are returned directly to the boilers by means of a gravity return system.

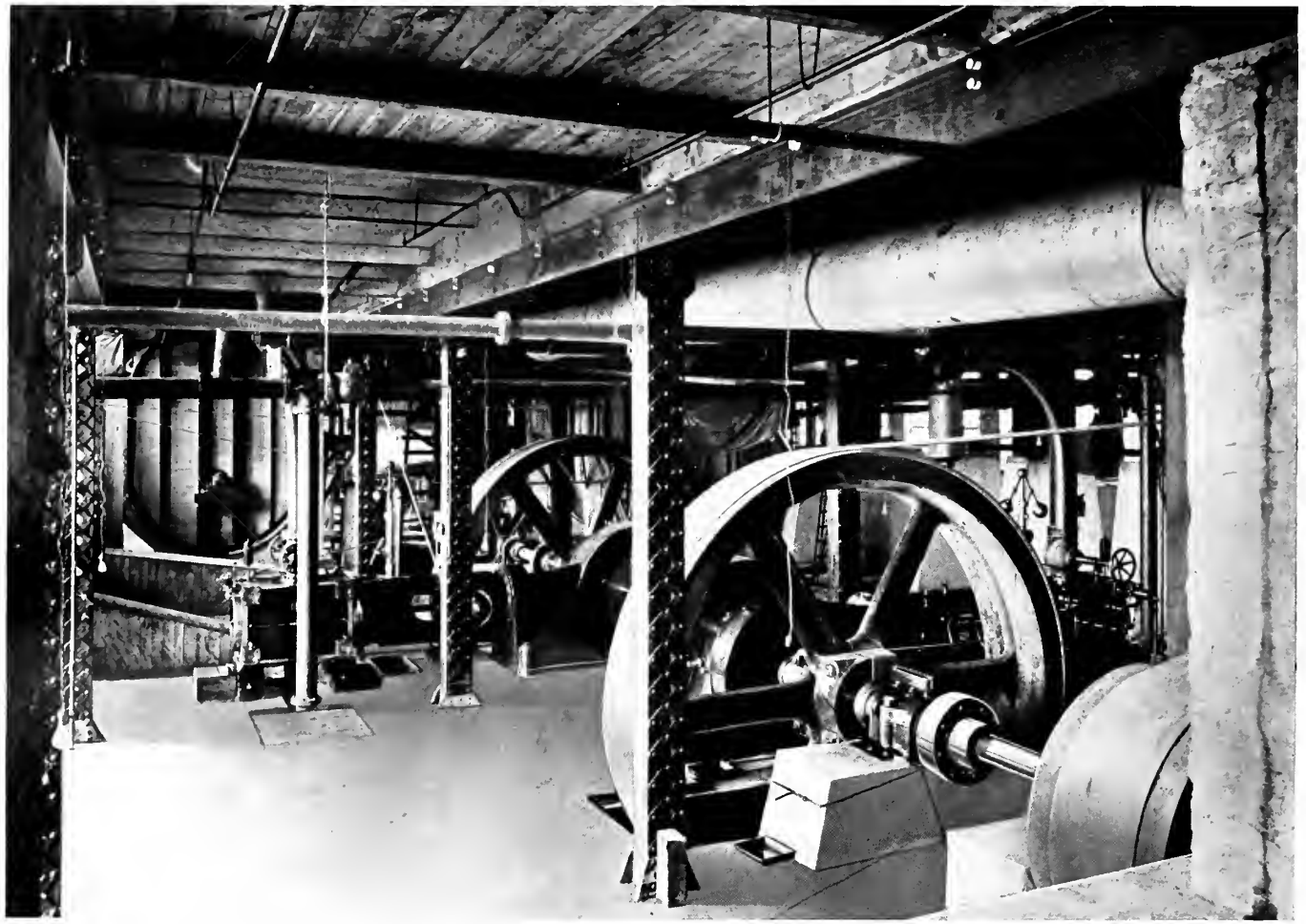
An alternating current equipment is used throughout the plant, except for the needs of the tramways, which are operated by a 35 K. W., 550 volt continuous current generator driven by a 50 H. P., 550 volt alternating current motor. A Vermont marble switchboard, 25 feet 4 inches long, 7 feet 6 inches high, consists of twelve panels, four generator, two exciter, one regulator, four power feed and one lighting feed panel. All feeder cables outside the buildings run underground in terra cotta ducts; inside, they run overhead. The cables are covered with hard polished finish underwriter insulation, except where exposed to acid fumes, where they are rubber covered.

The heating of the plant is effected by three units, and each consists of a direct connected engine, fan, and coils. Two large units heat the paper mill and prevent condensation; the third heats the sulphite mill. The motors are all three-phase 40-cycle, 550 volts, induction motors with starting resistance inside the armatures.

The decision as to the general type of construction and the material to be used in different portions of the plant, was governed by the material available, considered from the points of suitability and economy, and the character of the sites.

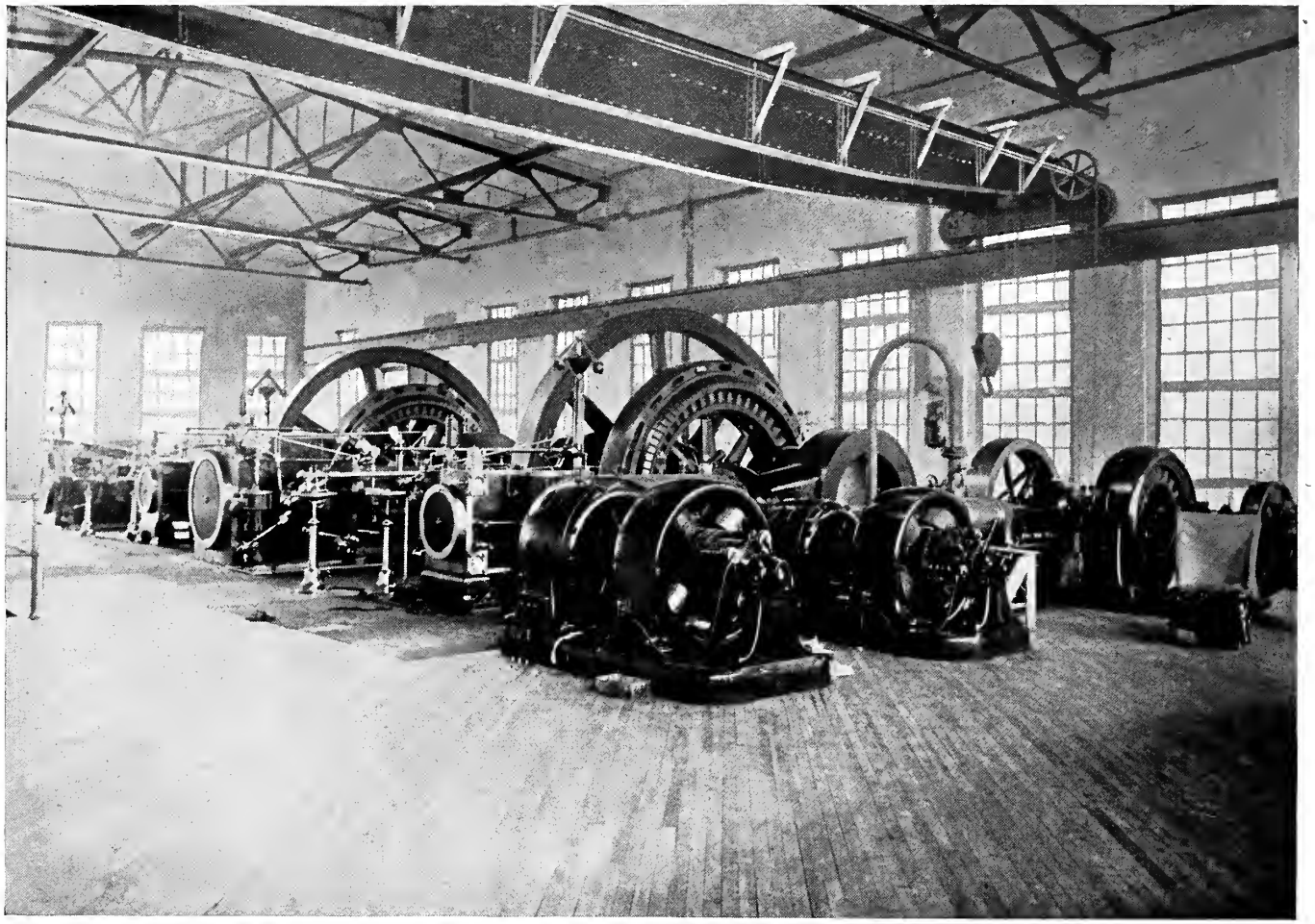
The boiler house is improved over the usual paper mill boiler house in many ways, noticeably by the bunker for handling the fuel supply.

BOILER ROOM. Munising Paper Company, Ltd., Munising, Michigan.



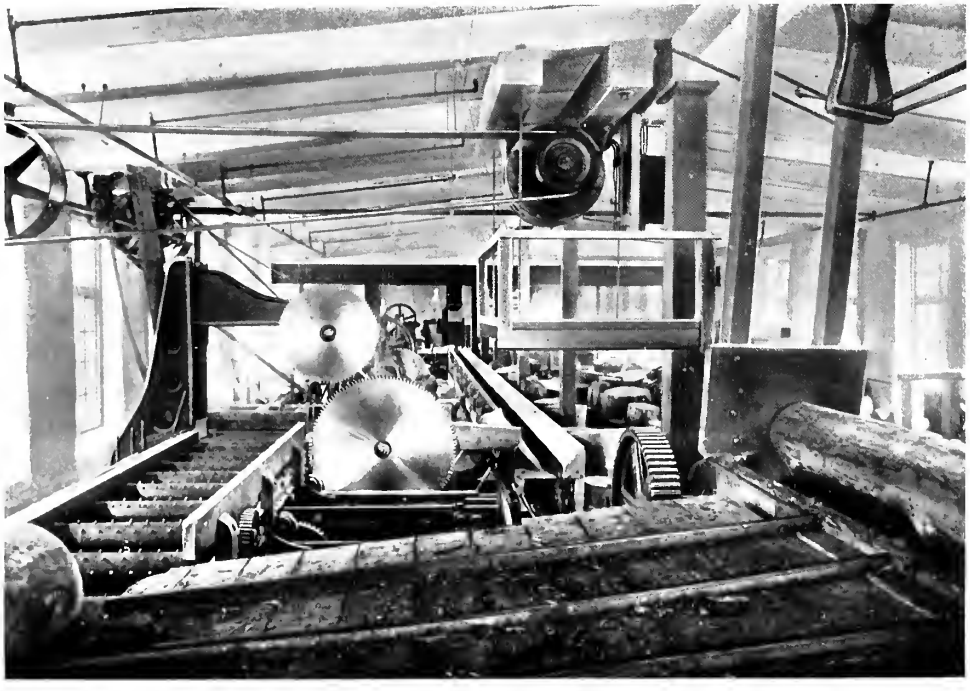
PAPER MACHINE ENGINES.

Munising Paper Company, Ltd., Munising, Michigan.

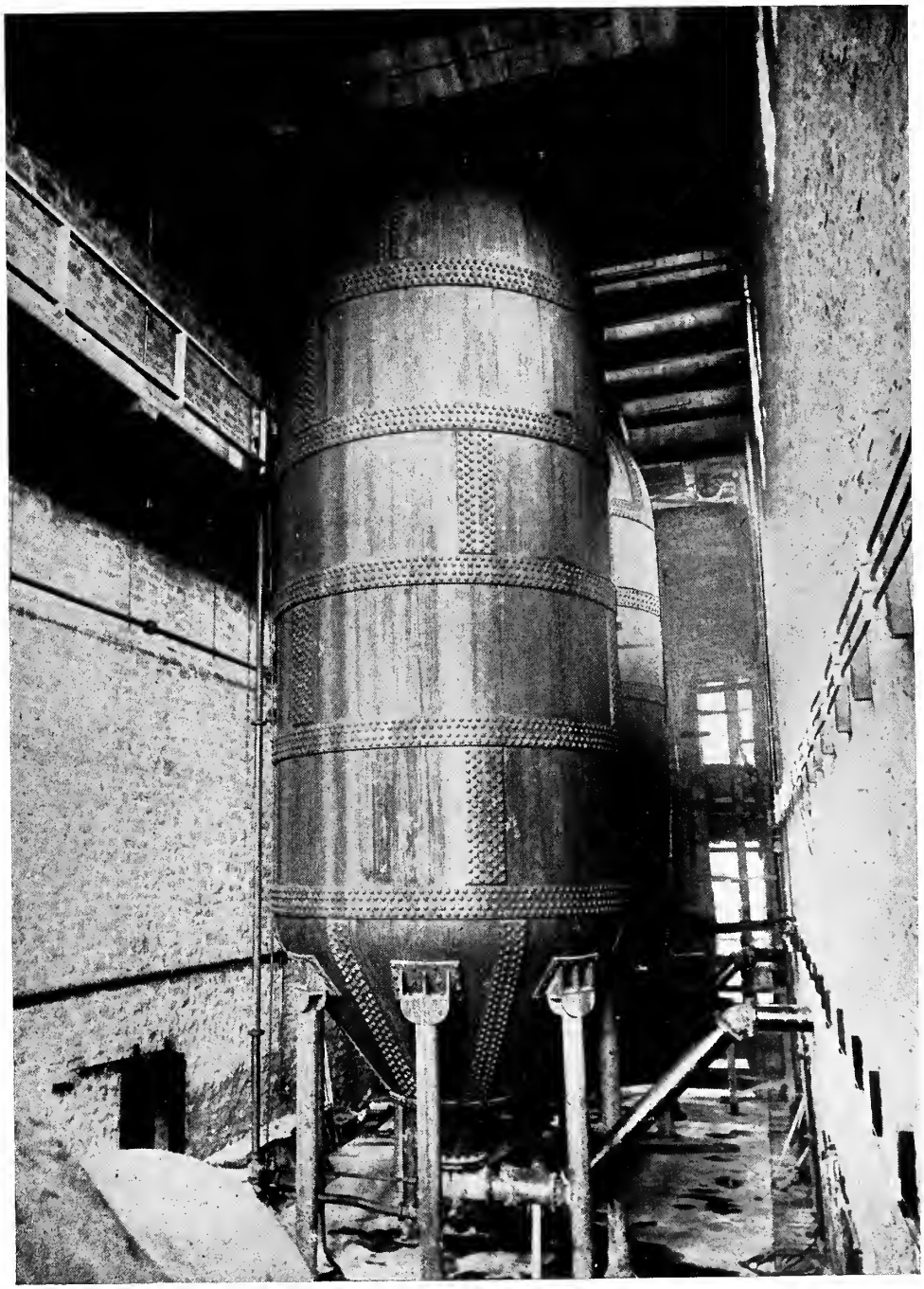


MAIN POWER ROOM.

Munising Paper Company, Ltd., Munising, Michigan.



LOG YARD AND WOOD PREPARING ROOM.
Munising Paper Company, Ltd., Munising, Michigan.



DIGESTER ROOM.

Munising Paper Company, Ltd., Munising, Michigan.

SCREENS AND WET MACHINES.

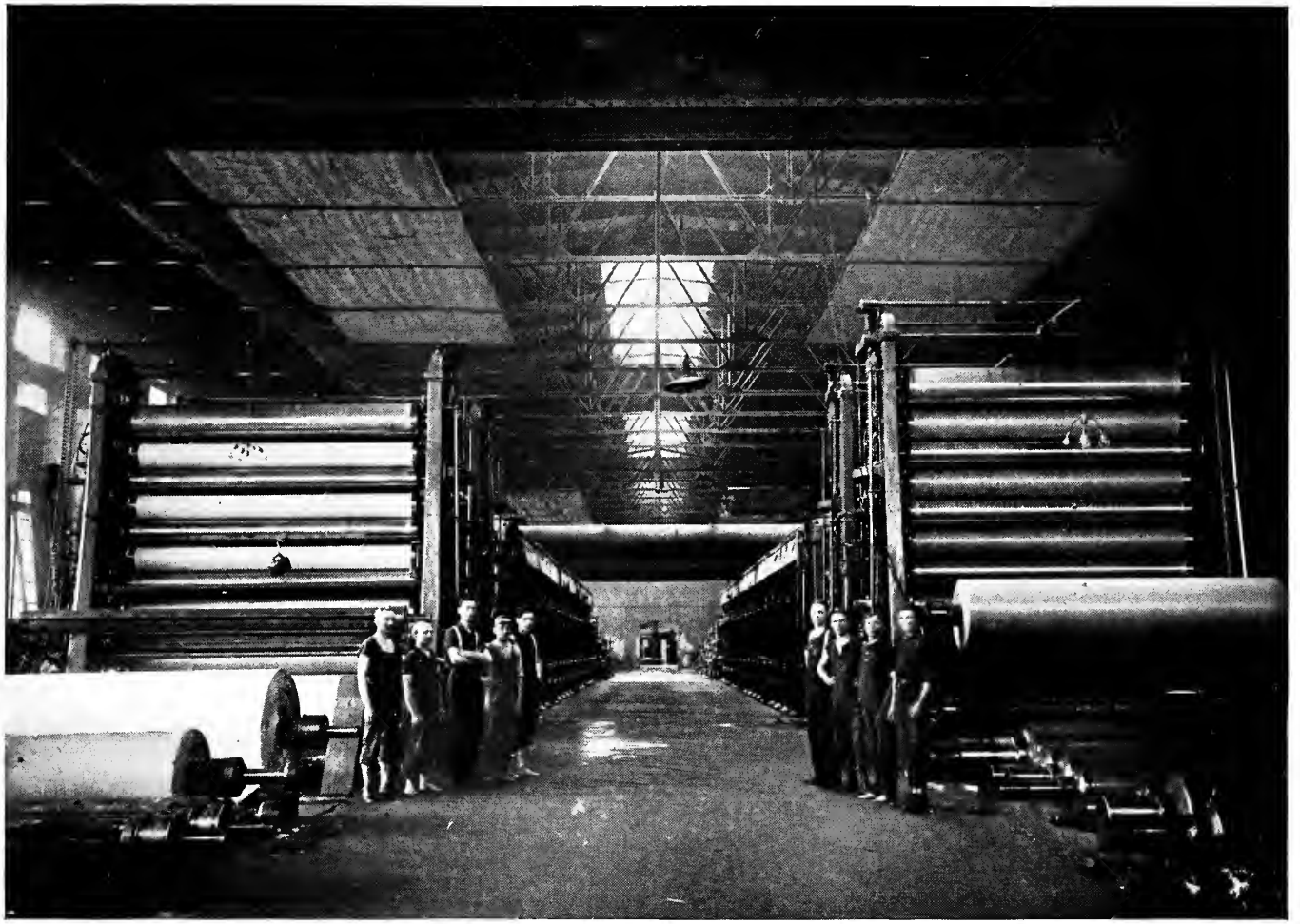
Munising Paper Company, Ltd., Munising, Michigan.

BEATING ENGINE ROOM.

Munising Paper Company, Ltd., Munising, Michigan.

MACHINE ROOM.

Munising Paper Company, Ltd., Munising, Michigan.



MACHINE ROOM.

Munising Paper Company, Ltd., Munising, Michigan.

CAMBRIDGE ELECTRIC LIGHT CO., CAMBRIDGE, MASS.

The Cambridge Electric Light Company furnishes electric light and power for the city of Cambridge, Massachusetts, and includes in its output, current for street arc lamps, incandescent lights for municipal and private use, and power for various industrial purposes.

This plant is the third built by the company since its organization in 1886, and is planned for possible future extensions with a full realization of the rapid growth of power plants of this class. It is situated on the banks of the Charles River in Cambridge, where an abundance of cold water is obtainable for condensing purposes. Owing to a projected parkway along the banks of the river, the company have erected a building which will be in keeping with future surroundings so far as the nature of such a structure will permit.

The building, as will be seen by the plan, is rectangular in shape, 165 feet in length by 100 feet in width, and divided through the entire length by a partition wall that separates the engines from the boilers. It is constructed of steel and red brick, with pink granite foundations, and surmounted with a copper cornice and iron grille. The very large arched windows give excellent light in the interior.

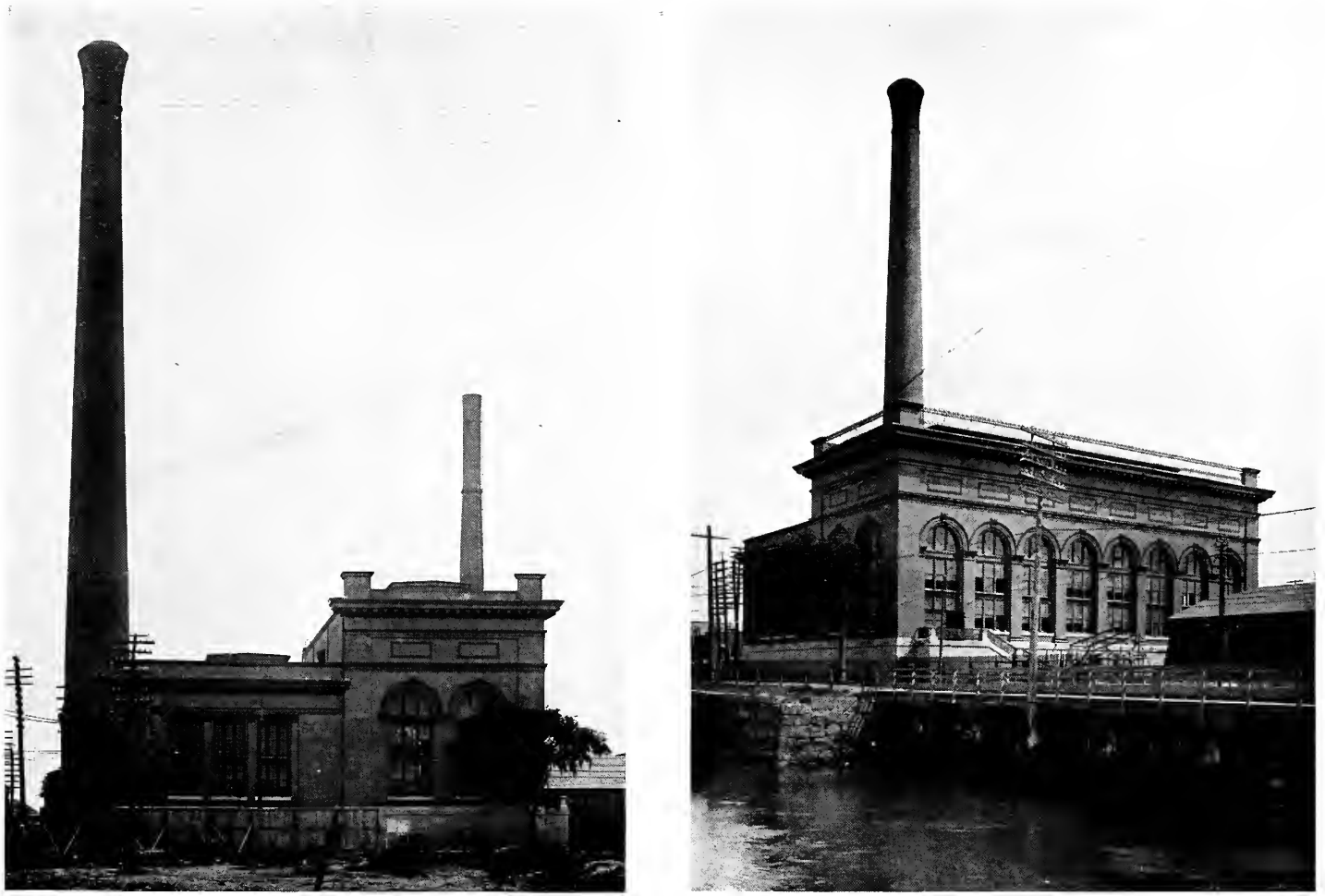
Both the engine room and boiler room have traveling cranes, which facilitate the handling of heavy pieces of machinery and making repairs.

Coal and ashes are handled by means of cars, from which coal is fired by hand into the furnaces, and into which ashes are drawn from the hoppers that constitute the bottom of the ash pits under the grates.

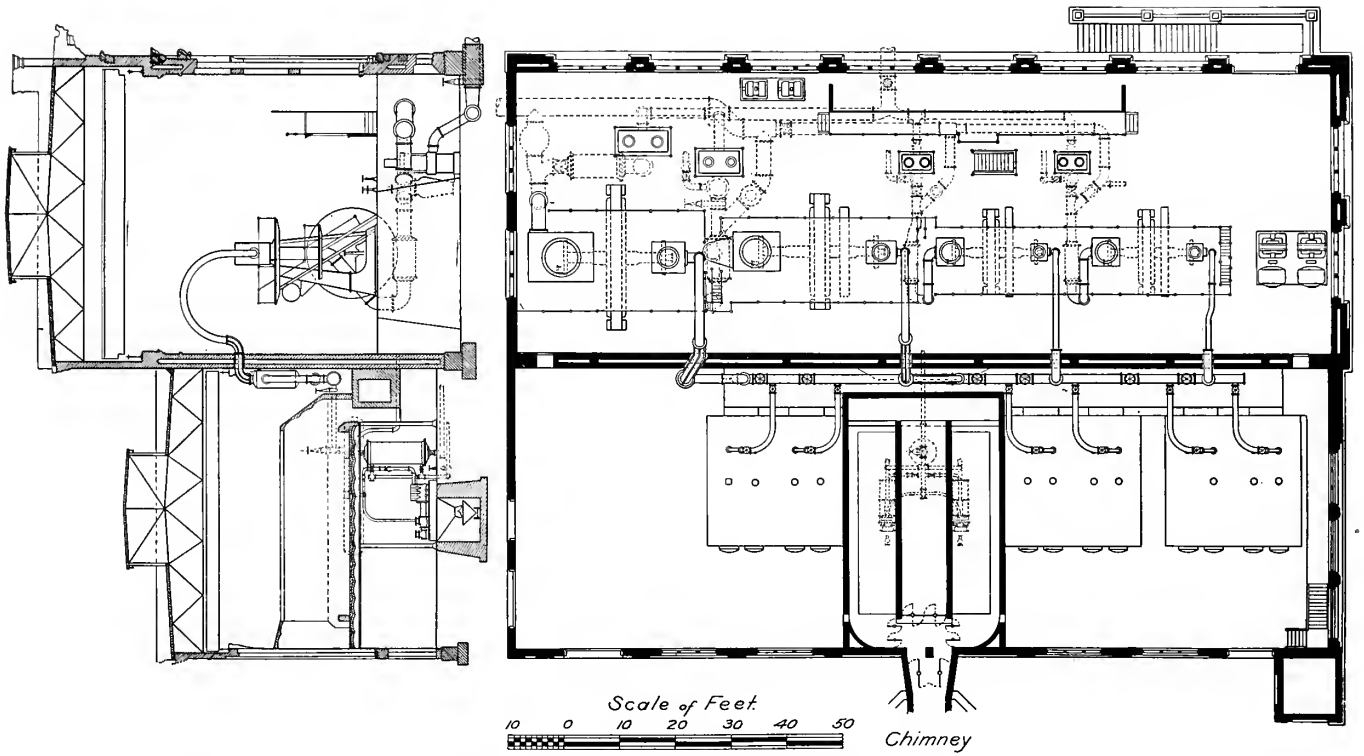
The boilers are fitted with internal superheaters, in units of 440 horse power each, and carry a usual steam pressure of 150 lbs. per square inch. Natural draft produced by a brick chimney 255 feet high, with a circular flue 9 feet in diameter, is controlled by means of a hydraulic damper regulator, which automatically regulates the steam pressure.

As the heating of boiler feed water by means of what would otherwise be wasted heat is a source of considerable economy, the water is passed through a series of feed water heaters before entering the boilers. These feed water heaters are comprised of tubes through which the feed water is passed and around which exhaust steam circulates after it has done its work in the various pumps and engines. From this type of heater, the water is passed through the fuel economizers, where the temperature is still further raised, and the water enters the boilers hot enough to be converted directly into steam.

The steam engines that drive the electric generators are on the second floor of the engine house. The foundations for these engines are placed in the first story, and the space not occupied by them is utilized for condensers and vacuum pumps, oiling system, electrical ducts and pipes. These engines are of the vertical, compound, condensing type,



POWER PLANT OF THE CAMBRIDGE ELECTRIC LIGHT COMPANY, CAMBRIDGE, MASS.



PLAN AND SECTION.

Cambridge Electric Light Company, Cambridge, Mass.

BATTERY OF B. & W. BOILERS.

Cambridge Electric Light Company, Cambridge, Mass.

direct connected to generators. They aggregate over 7,100 horse power in four units and are capable of developing over 10,000 horse power when occasion demands. They are lubricated by a pressure oiling system, in which oil is piped direct to each lubricator, and after passing through the bearings, the oil is drawn to a filter, where impurities are taken out and it is ready to be used again. They operate normally with superheated steam at 150 lbs pressure, and exhaust to condensers at 28 inches vacuum.

The condensers are what are known as the jet type, the exhaust steam mingling with the cooling water on its passage through the condenser. Attached to each is a double, vertical, single acting vacuum pump driven by vertical steam engines mounted above the pump cylinders.

Particular attention has been given to the saving of all condensation which may collect in the high pressure steam pipes, and this hot water is returned to the boilers by means of a gravity return system, which automatically returns the condensation as fast as it collects. All hot water which is not contaminated with oil is thereby reclaimed and again converted into steam.

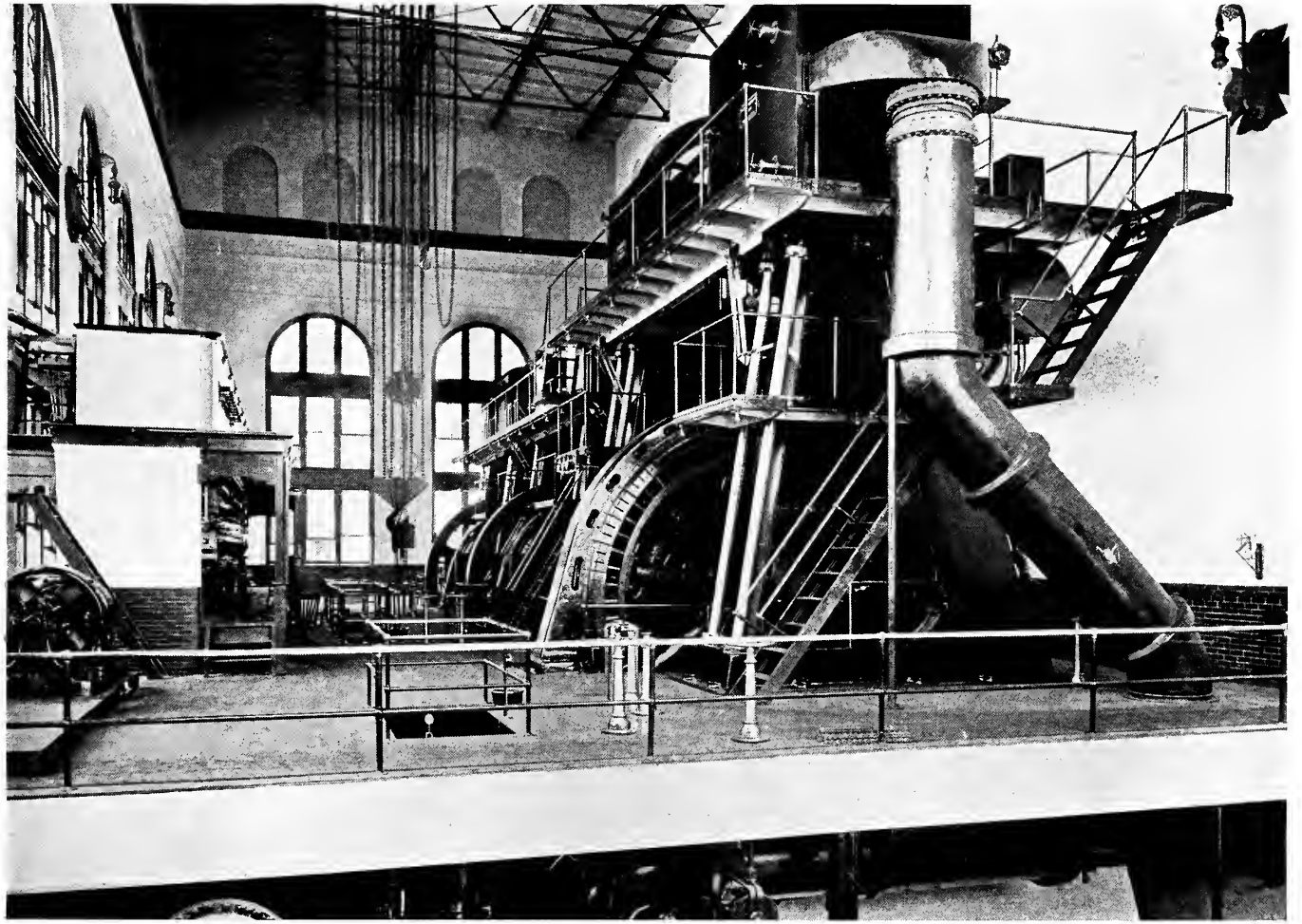
The high pressure piping system is designed to adjust itself to the variations due to expansion and contraction by the use of wrought steel bends, and the joints are of the most approved type with corrugated copper gaskets inserted. The entire system of hot pipes is covered with a thick lagging of insulating material to reduce radiation. Easy access to pipes and valves is obtained by means of iron galleries and stairs, which greatly facilitate the operation and maintenance of the plant.

The generators are 3 phase alternating current, developing a potential of 2300 volts, at which pressure a large part of the electrical output is transmitted to distributing centres in the electrical system and reduced by transformers.

As a part of the service demands direct current, "motor generators" have been installed.

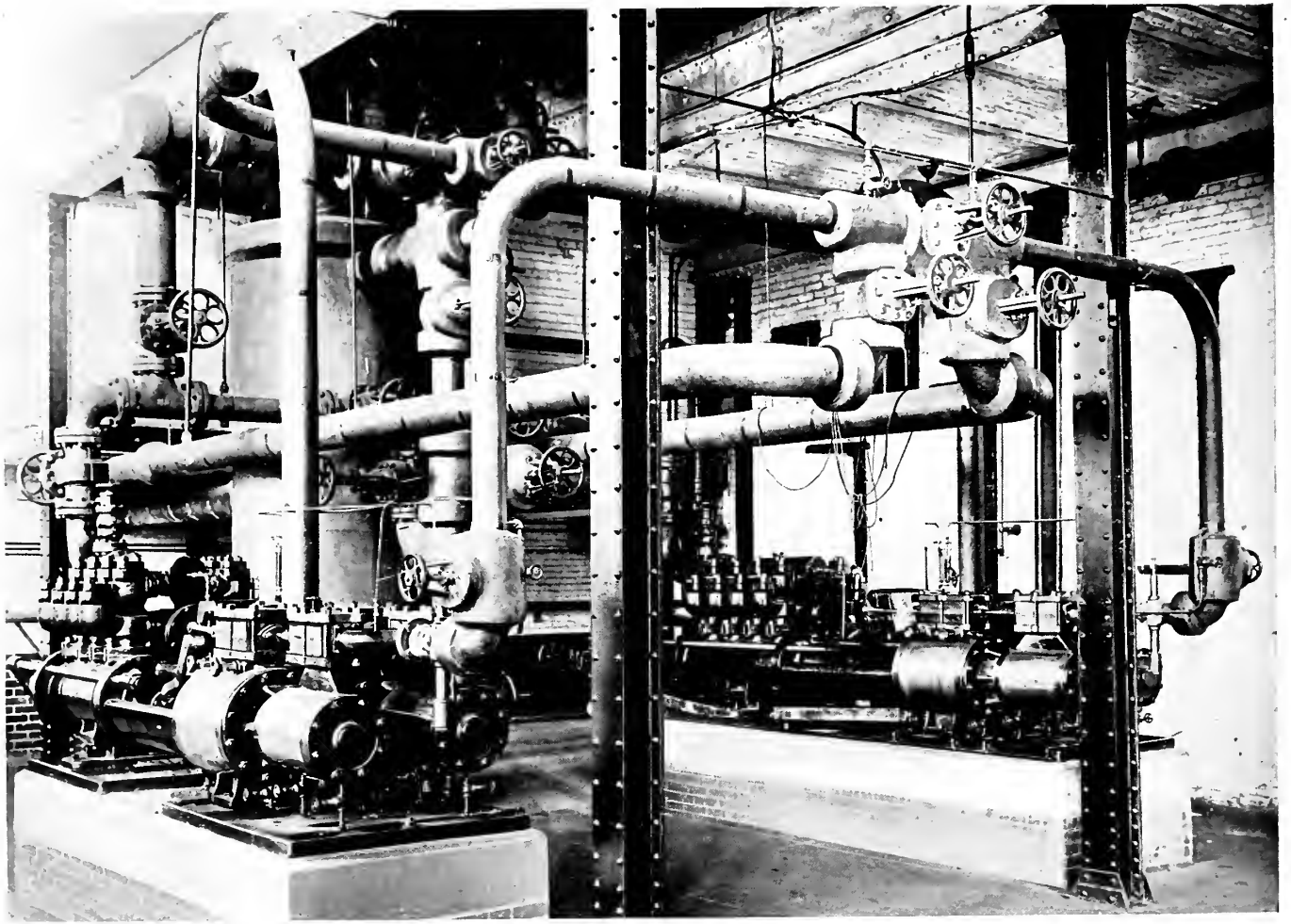
All electrical equipment is controlled by a switchboard, which is arranged along one side of the engine room on an elevated platform, screened off from the main room by a glass partition, through which the instruments may be observed. The switchboard is complete in indicating and recording instruments. All records are very carefully noted by the operating staff, and comparisons are frequently made with previous records, and with coal and water consumption. The efficiency of the entire system can be consistently followed, and deficiencies checked.

Below the switchboard in the basement are a series of constant current or "tub" transformers, which are used for the regulating of the arc light circuits, and which are automatic in their action. Conductors are led through conduits to a tower in the rear of the boiler room, where are lightning arresters for the protection of the station apparatus during thunder storms.



ENGINE AND GENERATOR ROOM.

Cambridge Electric Light Company, Cambridge, Mass.



BOILER PLANT AUXILIARIES.

Cambridge Electric Light Company, Cambridge, Mass.

THE QUINCY ELECTRIC LIGHT AND POWER CO., QUINCY, MASS.

The Quincy Electric Light and Power Company is a corporation doing a public service lighting and power business in the city of Quincy, Massachusetts.

Their power plant is built at tidewater, where water-borne coal can be conveniently landed at the boiler room door and where abundant water is available for condensers.

The building, constructed of red brick and Quincy granite, is ninety-six feet by eighty feet, with a projection on the front forty-three feet by seven feet, in which is placed the switchboard.

The plant is divided into a boiler room and an engine and generator room, the engine room being a two-story building. A brick partition separates one end of the boiler room from a series of rooms arranged on three floors, which are used for office, repair shop, storage, oil and toilet rooms.

The boiler room and engine room basement floors are at ground level, and the high basement in the engine room constitutes the first story of that portion of the building, thus giving good light and ventilation.

Below the basement floor are commodious trenches covered with iron plates, in which are the large water pipes supplying the condensers with cooling water.

The engine and boiler rooms have flat roofs with ventilating monitors admitting light in addition to that which comes through the large arched windows. Over the engines and traveling the entire length of the room is a fifteen ton, hand operated crane.

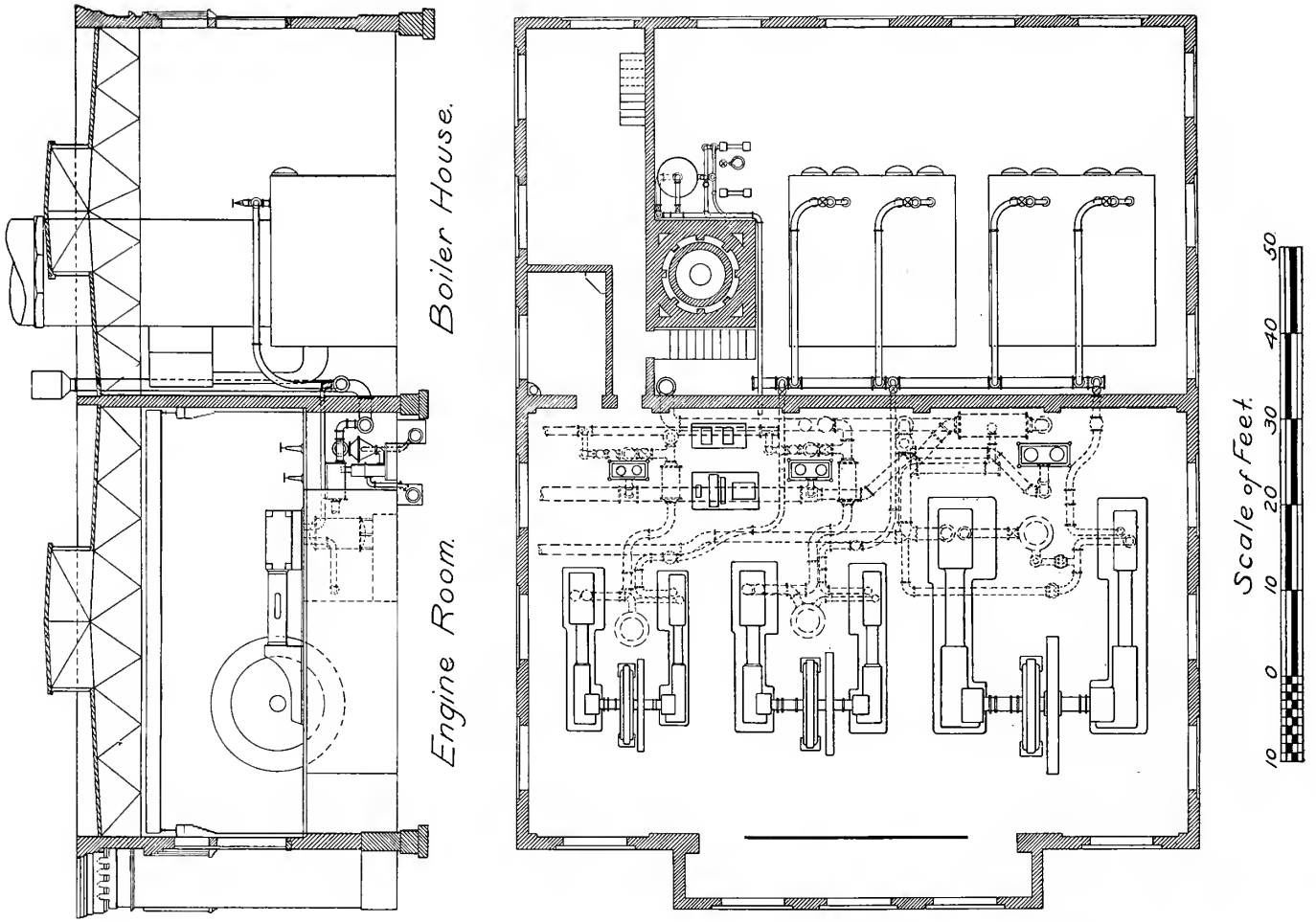
The plant is equipped with four units of water tube boilers, set in batteries of two each. The coal comes into the boiler house on small cars, from which it is fired by hand directly into the furnaces. Each car of coal is weighed on platform scales set in the boiler room floor, and a system of industrial railway tracks makes convenient handling of coal from the coal pocket on a wharf to the boiler house.

Steam is piped from the boilers into a main drum, which is suspended along the rear of the boilers, and from which it is distributed to the several engines. This drum and its branches are drained of condensation by a gravity system, which returns the water to the boilers under full boiler pressure. The boilers are fed with water taken from the city water mains.

Provisions are made in the feed water piping system to shut out any of the feed water heaters in case of repairs, and a further precaution is taken to provide the boilers with cold water by a separate course.

In the engine room are three units of compound condensing Corliss engines.

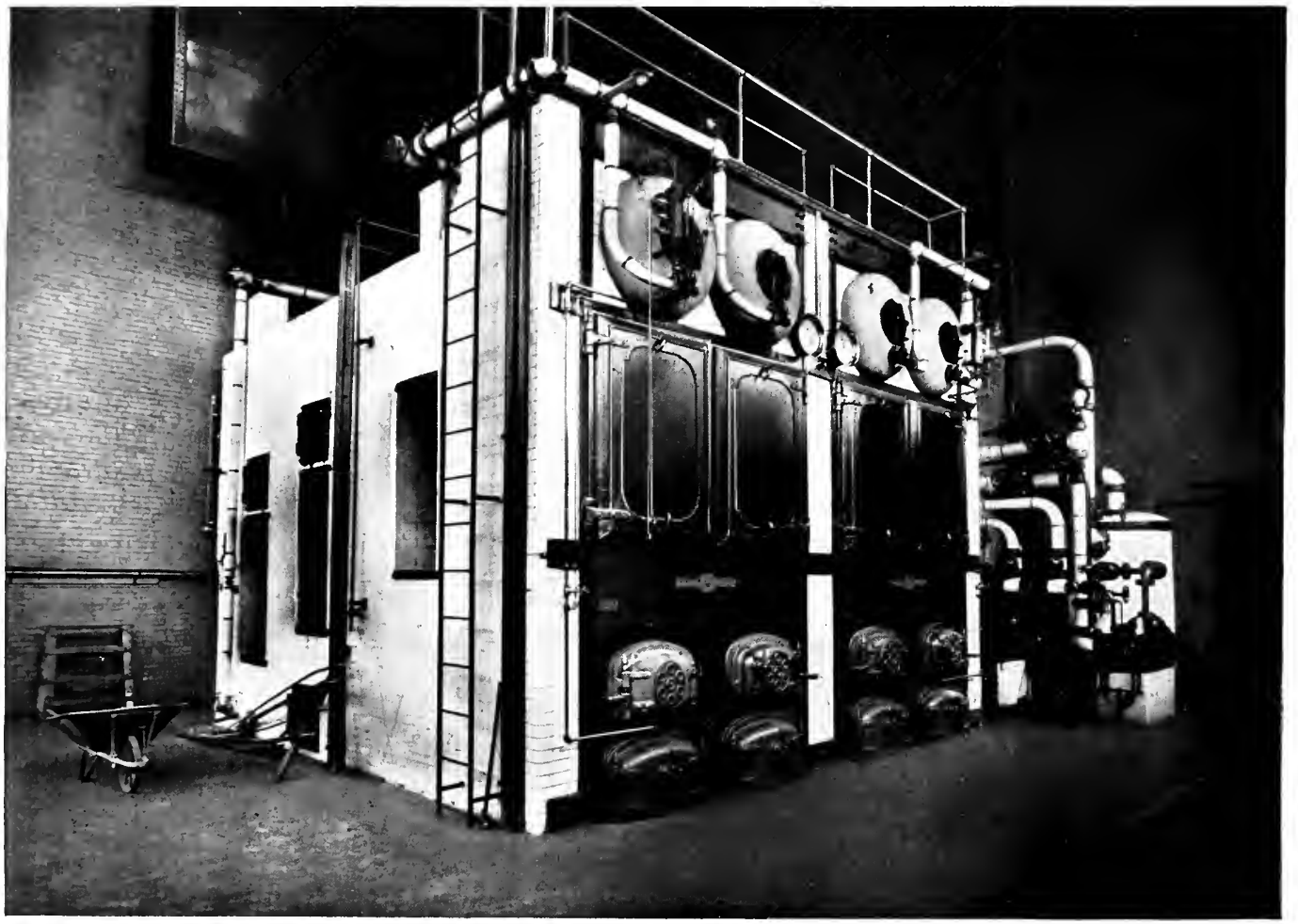
Between the high and low pressure cylinders are reheating receivers with connecting pipes and valves so arranged that either or both cylinders may be used. While the usual method of running is with both cylinders, that is, with the high pressure exhausting into the low pressure, in case of accident, the disabled side may be dismantled and the other operated until repairs can be made.



PLAN AND SECTION.

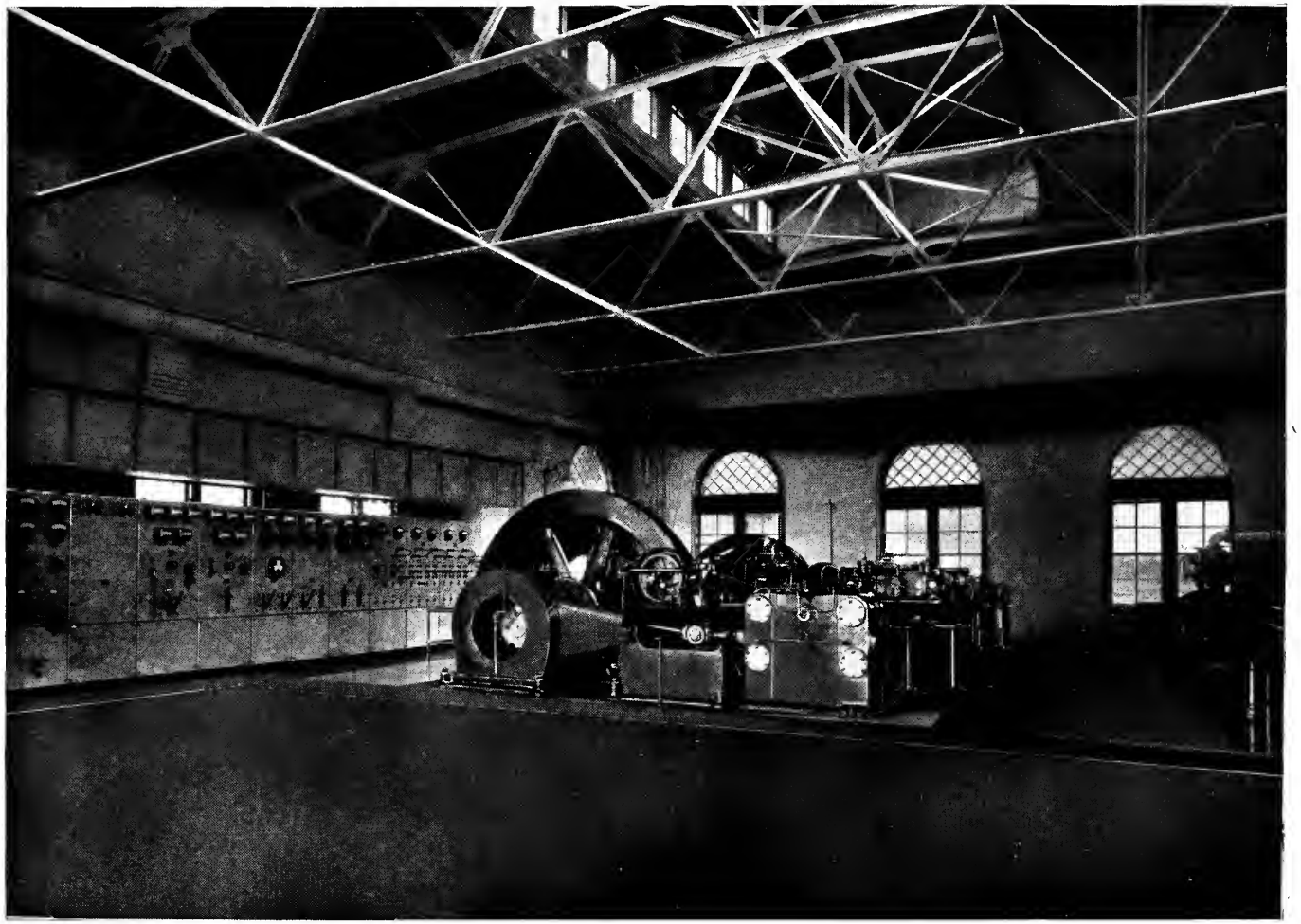
Quincy Electric Light and Power Company, Quincy, Mass.

QUINCY ELECTRIC LIGHT AND POWER CO., QUINCY, MASS.



BATTERY OF B. & W. BOILERS.

Quincy Electric Light and Power Company, Quincy, Mass.



ENGINE AND GENERATOR ROOM. Quincy Electric Light and Power Company, Quincy, Mass.

ROANOKE RAPIDS PAPER MFG. CO., ROANOKE RAPIDS, N. C., U. S. A.

This plant is an example of the possibilities of southern developments. The raw material is the second growth or "loblolly" pine of the Carolinas, the production, a general line of wrapping papers.

The first installation consisted of a one-machine paper mill and a small ground wood pulp plant of four standard three pocket grinders. Provision was made for an additional paper machine and for a chemical fibre plant, when the conditions should warrant the increase, and already the first installation of the fibre plant has been added.

A penstock from the Roanoke Rapids Power Co.'s canal extends to the river end of the beating engine building, where two steel wheel cases are located outside the building in such a position that the wheel shafts extend longitudinally within the beater engine basement. This basement also forms the grinder room and room for Jordan and machine chests. One of these shafts is direct connected to four grinders, the other forming the main line of the mill, from which the beating engines, Jordans, and Jordan chests, as well as water supply and general equipment of beating engine room are belted.

The screen and wet machines, pumps, chests and miscellaneous ground wood equipment are belted from the grinder shaft, and the ground wood plant is thus made entirely independent of the paper mill operation.

No separate buildings were erected for the ground wood pulp plant. The screen and wet machines are located on the main floor of the beating engine room convenient for handling the pulp to beaters and where the labor of operation can be kept at a minimum. The ground wood plant has a daily production of from 12 to 16 tons of good quality pulp.

The topography of the site was ideal for economy of installation.

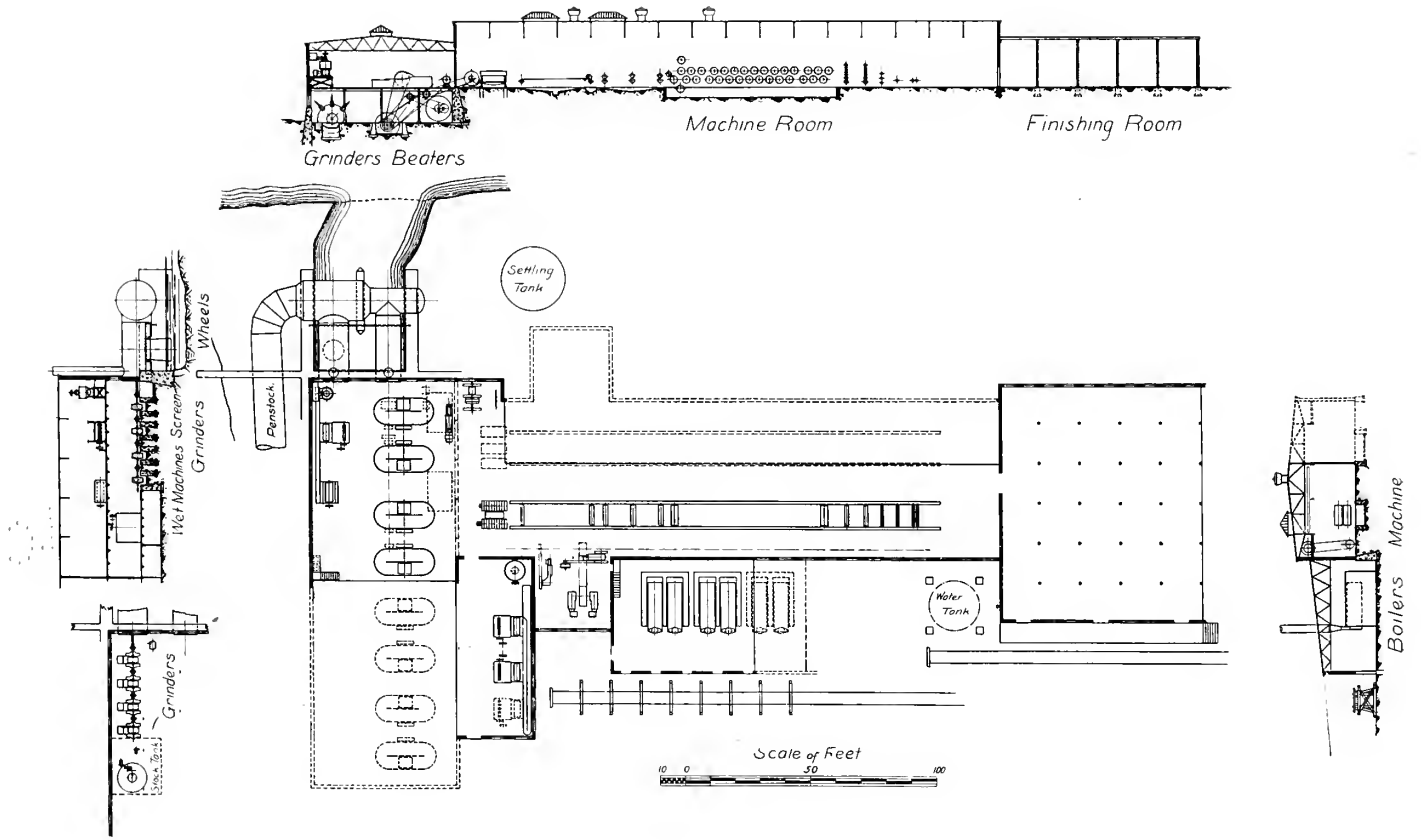
All floors throughout the paper mill are of concrete. The main floor of beating engine building is reinforced concrete on steel frame. Walls are brick where their location is a part of the ultimate two machine plant as designed, and are of wooden construction of a temporary character, where the future addition of a second machine will necessitate their removal.

The fibre plant, the second step in the development, has recently been put into operation. The product is strong sulphate pulp for "Kraft" Papers (the first pulp mill of its kind in the United States) and the product of the paper mill has been extended to include "Kraft" lines of wrapping papers.

The "Kraft" Pulp is produced by the methods of Carl P. Carlson, the noted Swedish chemical engineer, who is associated with this organization in all matters of sulphate pulp production. Mr. Carlson's success in this industry in Sweden, Norway and Finland is too well known to require comment.

PAPER MILL.

Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.

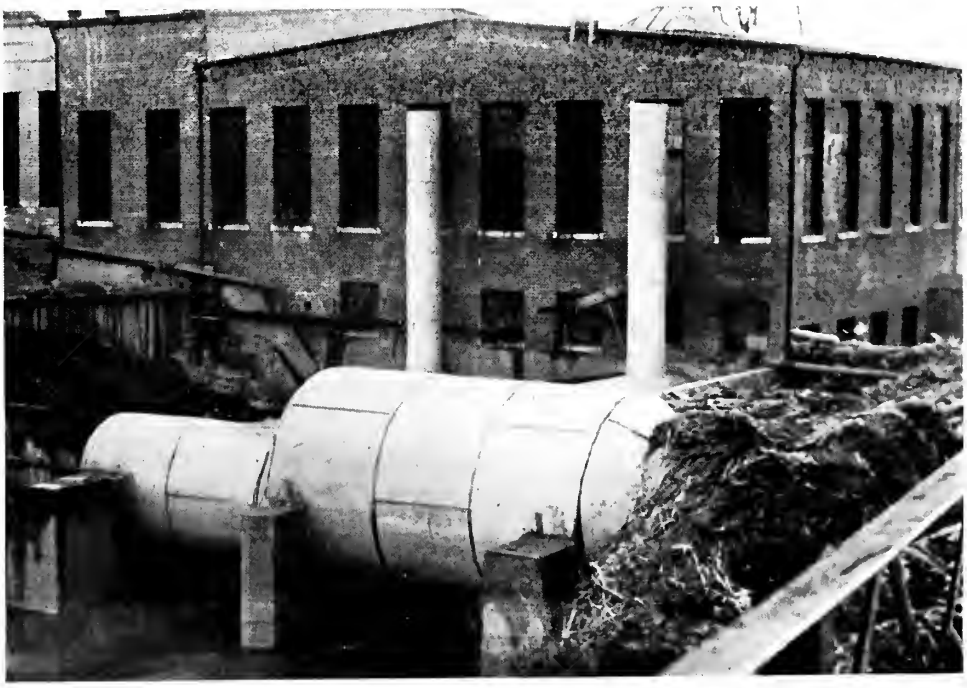


ARRANGEMENT OF PAPER MILL.

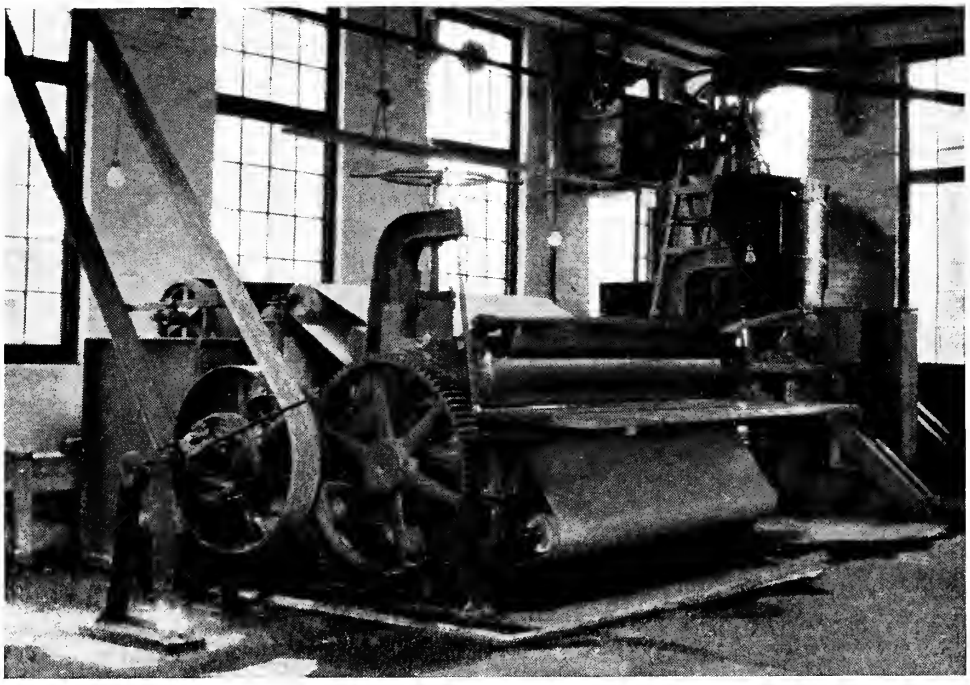
Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.

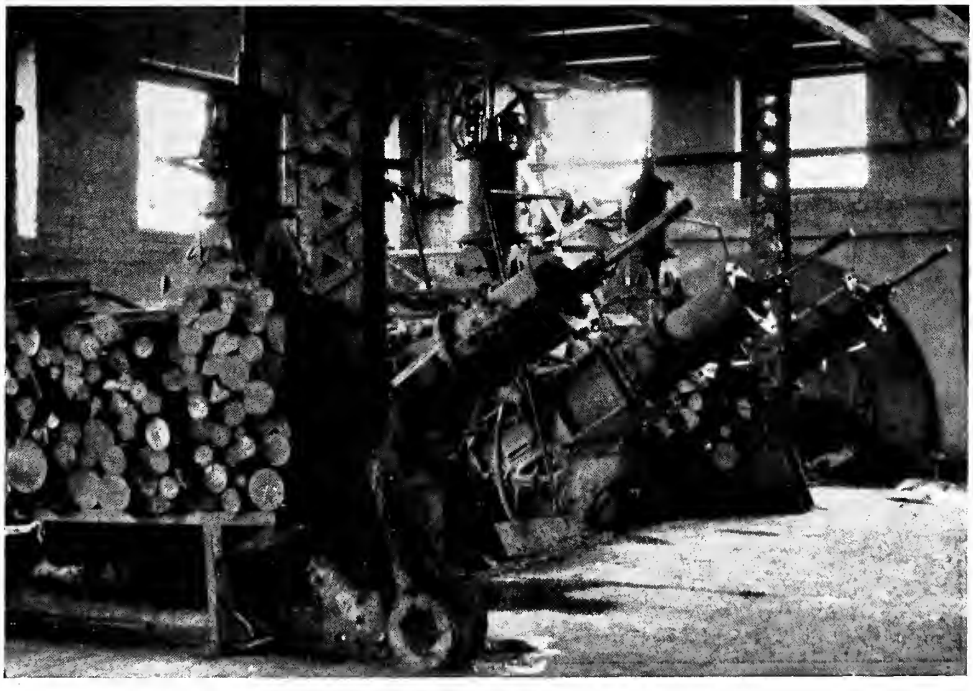
SULPHATE FIBRE MILL.

Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.

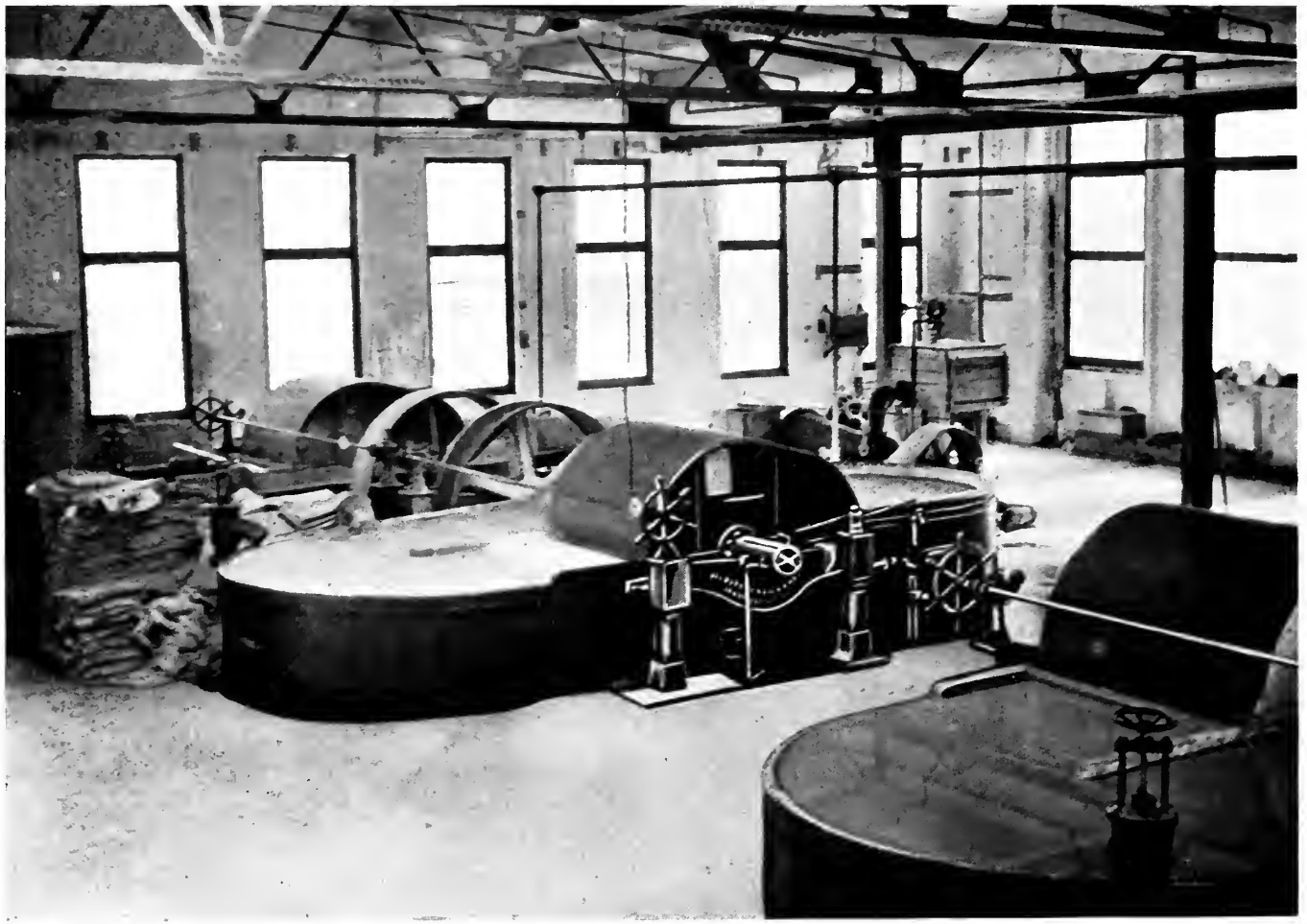


HEADGATES AND WHEEL CASES.
Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.



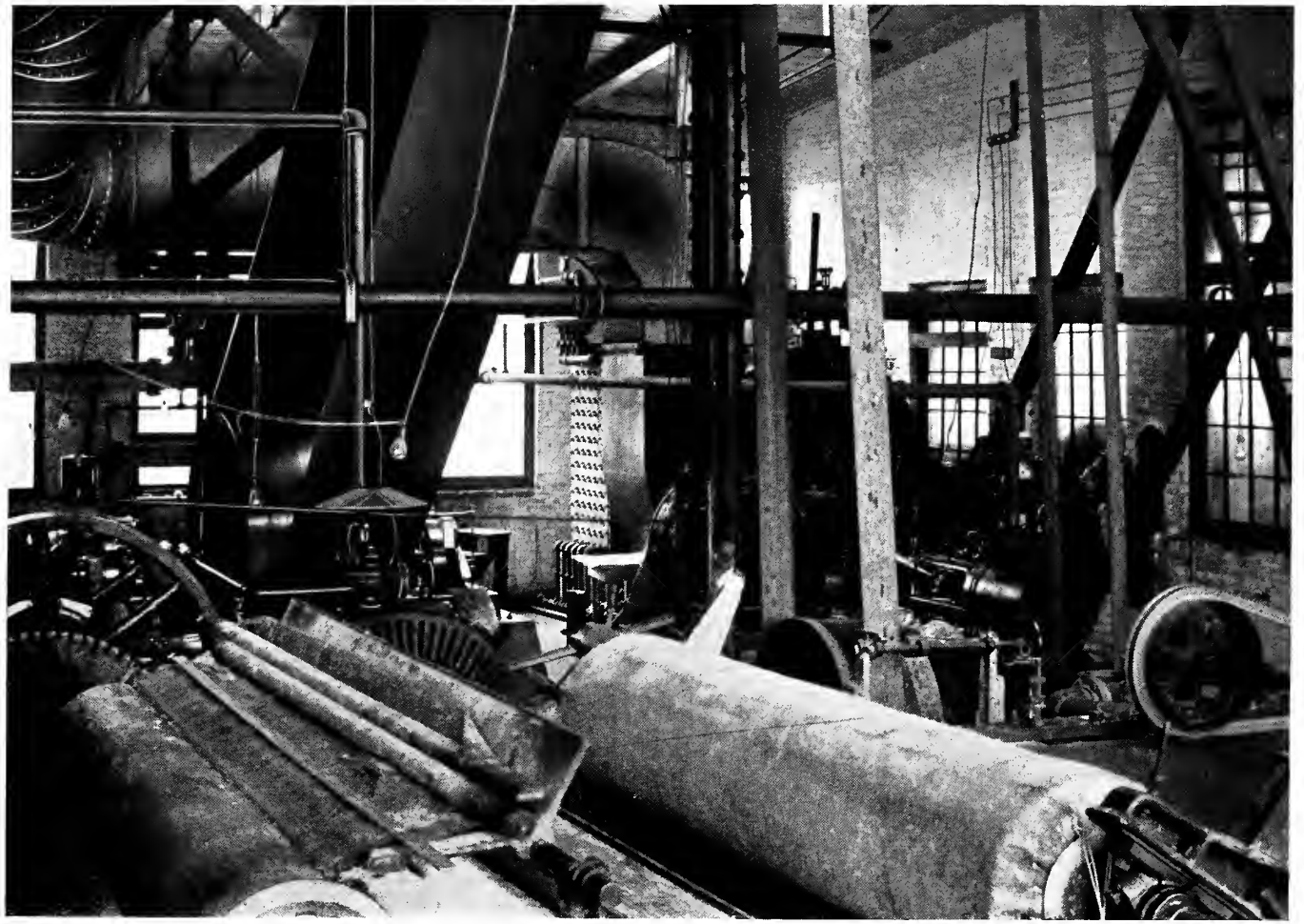


SCREENS, WET MACHINES AND GRINDERS.
Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.



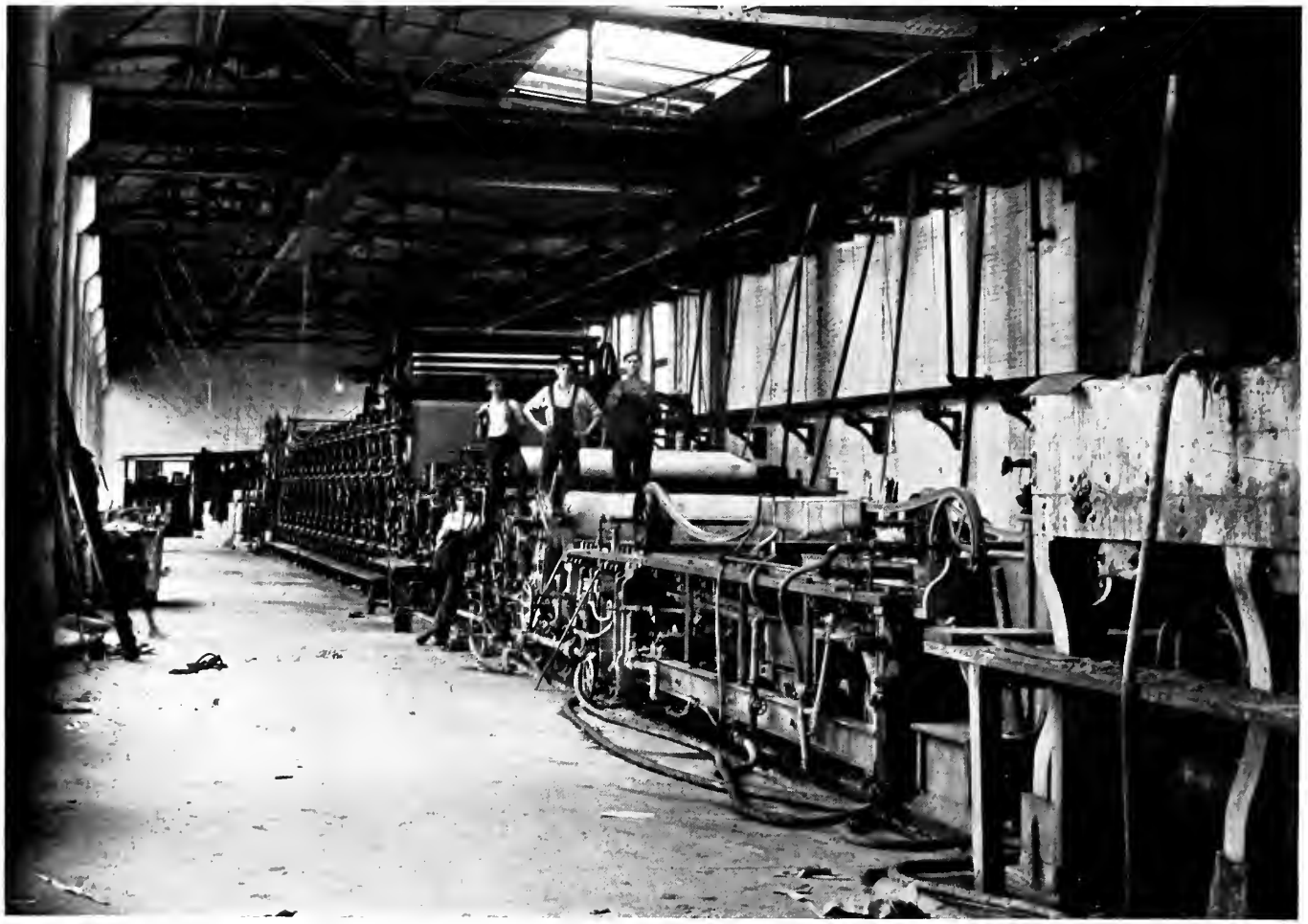
BEATING ENGINE ROOM.

Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.



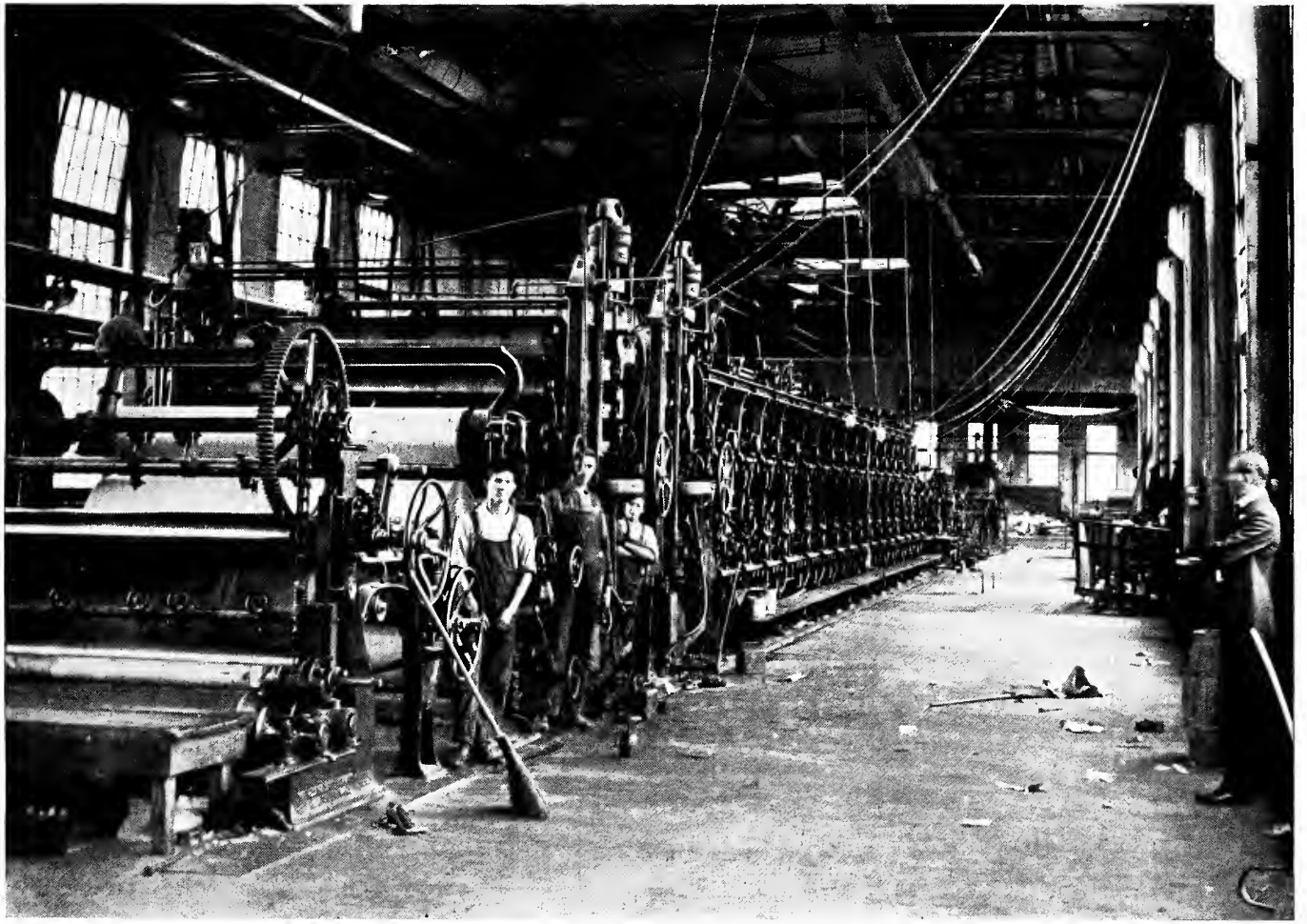
ENGINE ROOM FROM MACHINE.

Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.



MACHINE ROOM FROM WET END.

Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.



MACHINE ROOM FROM DRY END.

Roanoke Rapids Paper Manufacturing Company, Roanoke Rapids, N. C.

THE B. D. RISING PAPER CO., HOUSATONIC, BERKSHIRE COUNTY, MASS.

The plant of The B. D. Rising Paper Company comprises a group of substantial brick buildings erected previous to their acquirement by the Paper Company, so that the problem for the engineers was the adaptation of these buildings to the requirements of a fine writing paper plant.

Two of the principal buildings were used as rag preparing and beating buildings, respectively, and a machine building of sufficient length was secured by combining the central portion of the main structure and a rear wing into one.

New buildings were required for the steam plant, including engines and boilers, and for filters and bleach-making plant.

Much rearrangement was necessary and a steel floor system was substituted for wood in the main floor of the beating engine room. In order to secure sufficient depth of basement, the ground floor was excavated and the entire surface covered by a concrete slab on which the drainers and foundations were built.

The narrow building adjoining the beating engine and finishing rooms was used as the power building. Hydraulic turbines, penstocks, and necessary transmitting apparatus were installed therein, and an upper story was provided for rag boilers and accessories.

In the construction of this building and the tail-races underneath, quicksand was encountered and grillage was resorted to for foundations for all wheels and penstocks as well as masonry work.

The building selected for finishing was completed practically as it had been begun by previous owners, the two upper floors utilized as drying lofts, the two lower for supercalendering, cutting, ruling and general finishing, as well as for the mill offices.

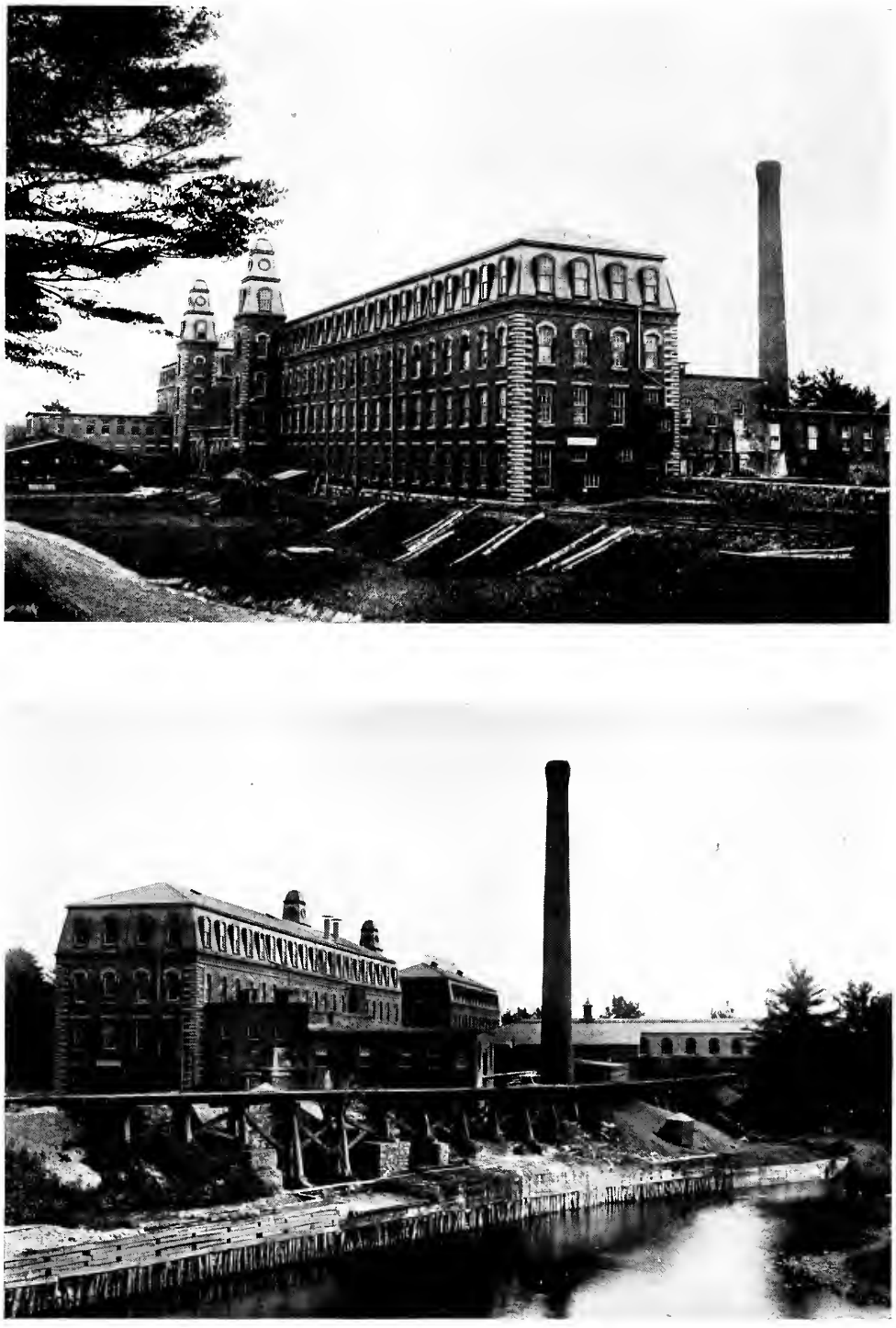
The water power privilege was improved and storage provided by raising the timber dam about nine feet, giving an operating head of 25 feet and a mill pond about a half mile in length. This necessitated the relocation of a great deal of county road, as well as the rearrangement of canals and headgates.

The canal walls are of rubble masonry supported on grillage and plank floor. The dam and other head work was largely done in winter and with satisfactory results despite climatic conditions and the unusual freshets occurring during its progress.

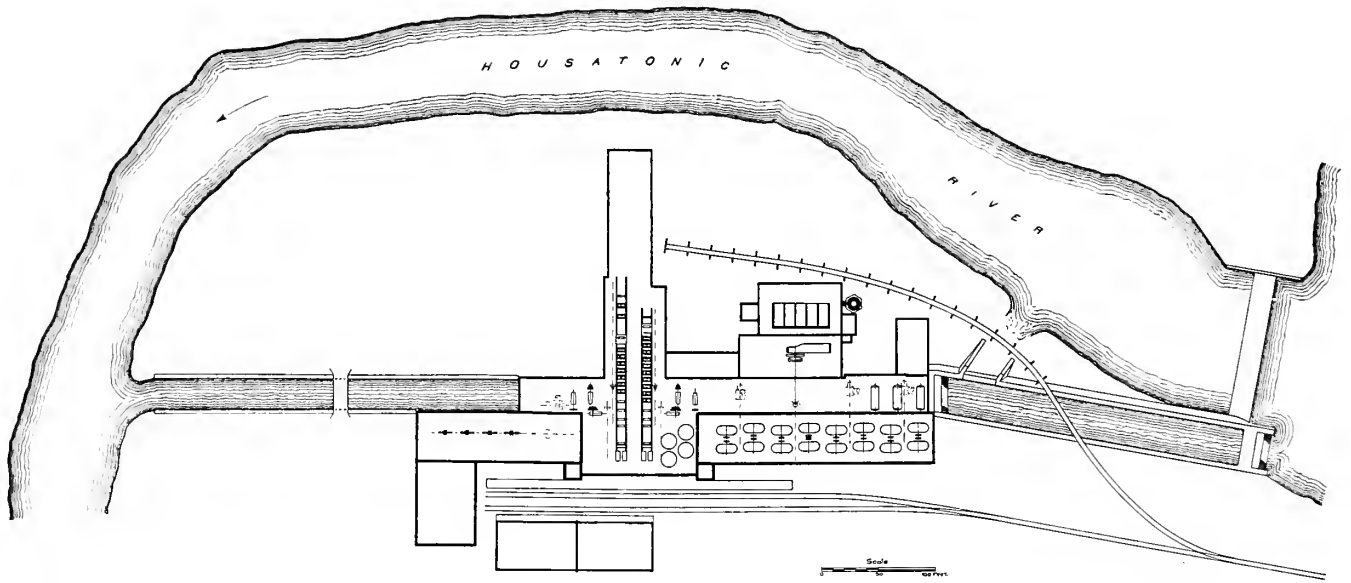
The wheel installation consists of five turbines and an auxiliary steam plant, to operate during low water periods, and so arranged that any or all the power lines of the plant may be operated by either water or steam as occasion demands.

Incoming stock and general supplies are delivered to a siding at the front of the plant, while bleach, rosin and coal are delivered to the trestle track in the rear.

The average production of the plant is twelve tons daily of loft dried bond and ledger papers and wedding and index bristol board.



B. D. RISING PAPER COMPANY, HOUSATONIC, MASS.

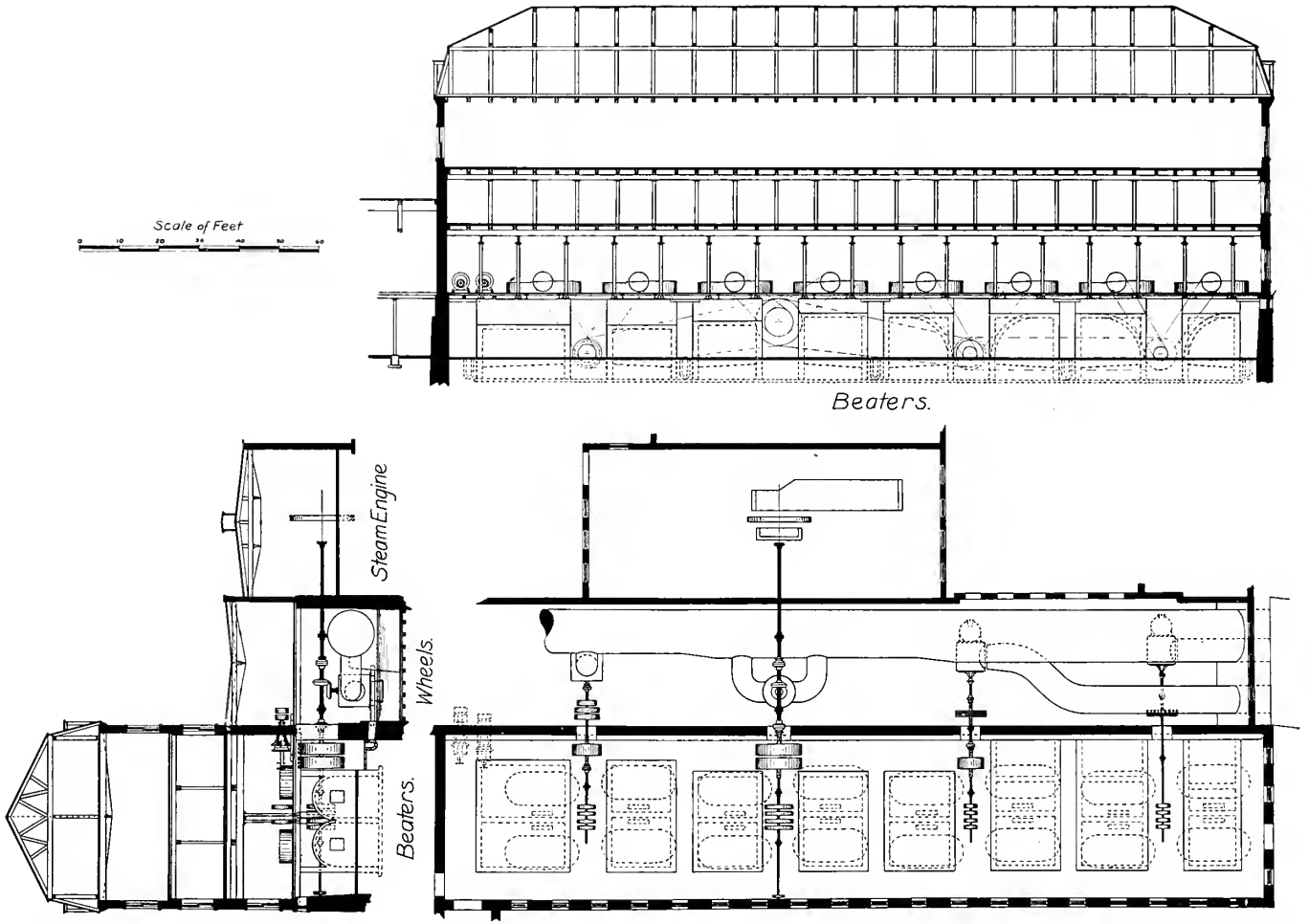


GENERAL PLAN.

B. D. Rising Paper Company,. Housatonic, Mass.

DAM, HEADGATES AND RAILWAY BRIDGE.

B. D. Rising Paper Company, Housatonic, Mass.



FLUME AND BEATING ENGINE BUILDING.

B. D. Rising Paper Company, Housatonic, Mass.

BEATING ENGINE ROOM.

B. D. Rising Paper Company, Housatonic, Mass.

AMERICAN STRAWBOARD COMPANY

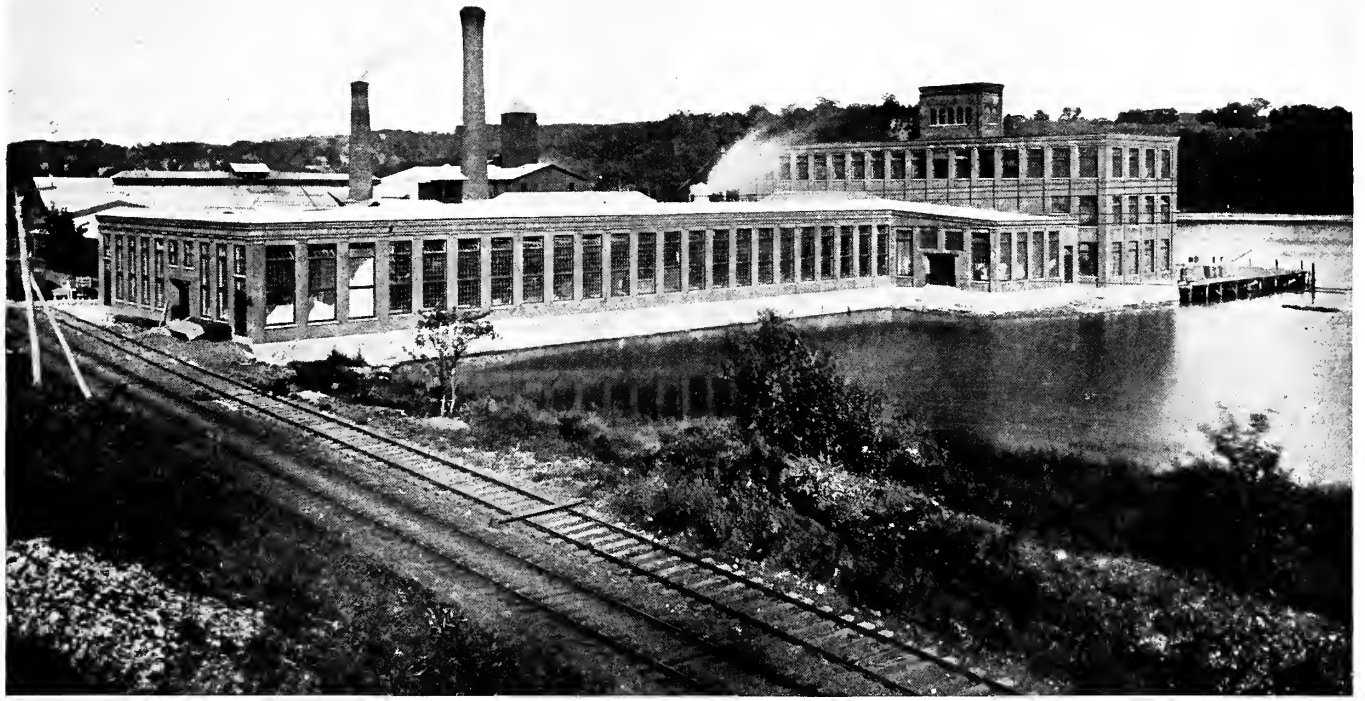
UNCAS PLANT, NORWICH, CONN.

The plant is a representative one for the manufacture of newsboard. It was built practically in the Thames River, at Norwich, Conn., on a siding of the Vermont Central R. R., and has its own dock with facilities for handling stock by water.

The mud flats on which the plant is located are submerged at ordinary level of tides and required piling under the entire plant.

The mill operates almost exclusively for raw material, on folded newspapers, purchased in New York City and transported by boat to storehouses on the dock. As required, they are then elevated to the top floor of main building and given preliminary treatment, thence by gravity to the beating engines and chests below. Two machines are installed and the production is about 60 tons, dry weight newsboard daily. The machines are located on the ground floor level with driving gear in the trusses and the steam engines in the building between the machines and boiler plant.

The peculiar foundation work necessary, on account of bad subsoil, proved very interesting from the engineering standpoint.



AMERICAN STRAWBOARD COMPANY (UNCAS PLANT), NORWICH, CONNECTICUT.

ROCHESTER, SYRACUSE AND EASTERN R. R. CO., LYONS, N. Y.

The power plant of the Rochester, Syracuse and Eastern R. R. Co., is situated at Lyons, New York, along the line of the New York Central and Hudson River Railroad, and operates a high speed electric railway. Electric power is generated as alternating current, transmitted to the substations along the line of the railway and converted into direct current, through rotary convertors. The power house is a brick and steel structure, divided into boiler, generator, and transformer rooms, each separated from the other by fire-proof partitions.

The generator room is a two story building with the generators on the second floor and a high basement for the first story. The boiler house is a high single story building planned for a double row of boilers with a central firing space between. Below the central firing space is provided a room into which ashes may be drawn directly from the ash pits under the boilers.

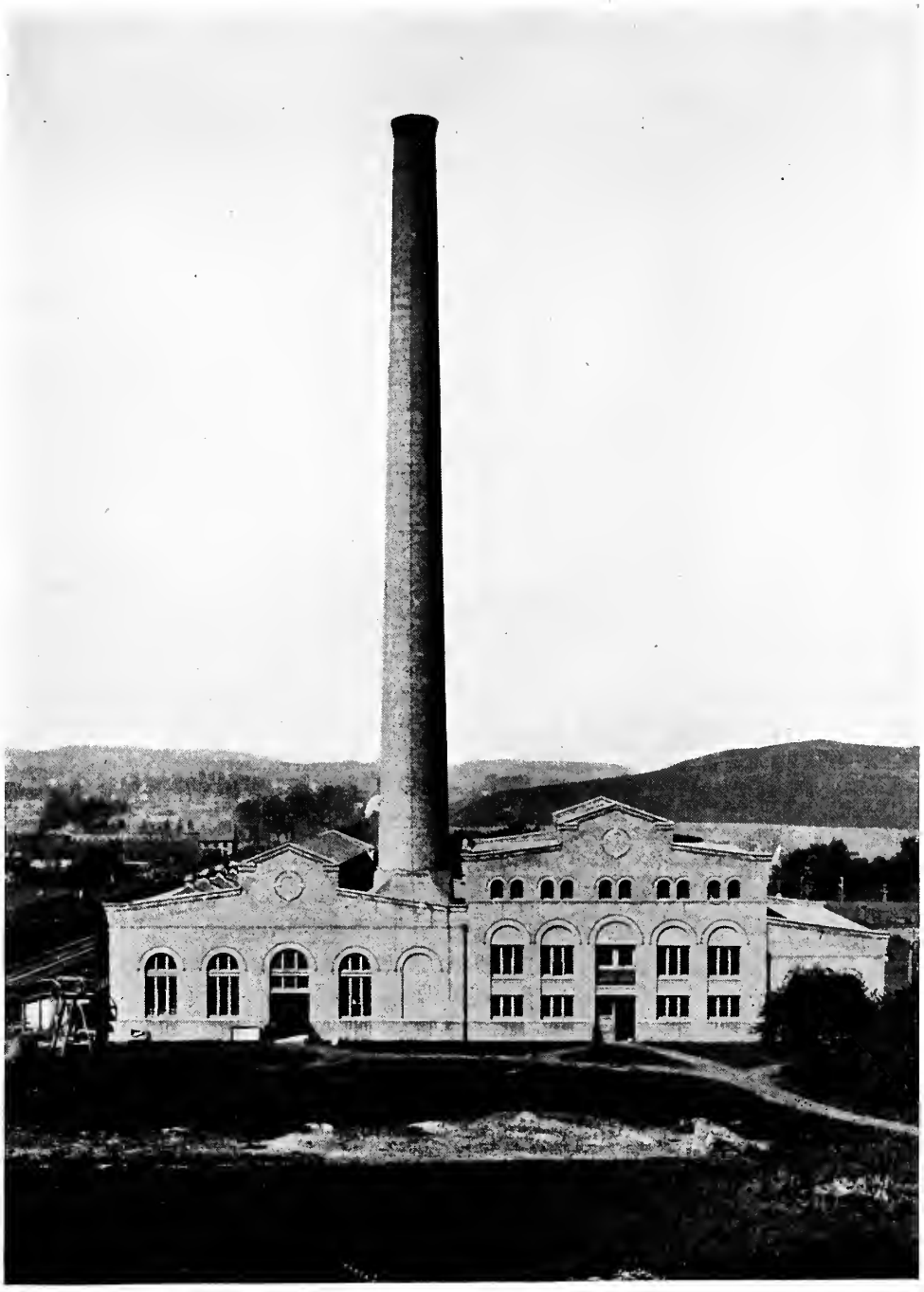
The transformer room consists of a single story projection on one side of the generator room and serves to house the transformers, all of the high tension switches, and conductors, and isolates this part of the equipment from the rest of the plant.

The current used is three phase alternating at twenty-five cycles per second and is produced by generators driven by horizontal steam turbines. There are two of these units each of 1500 K. W. capacity.

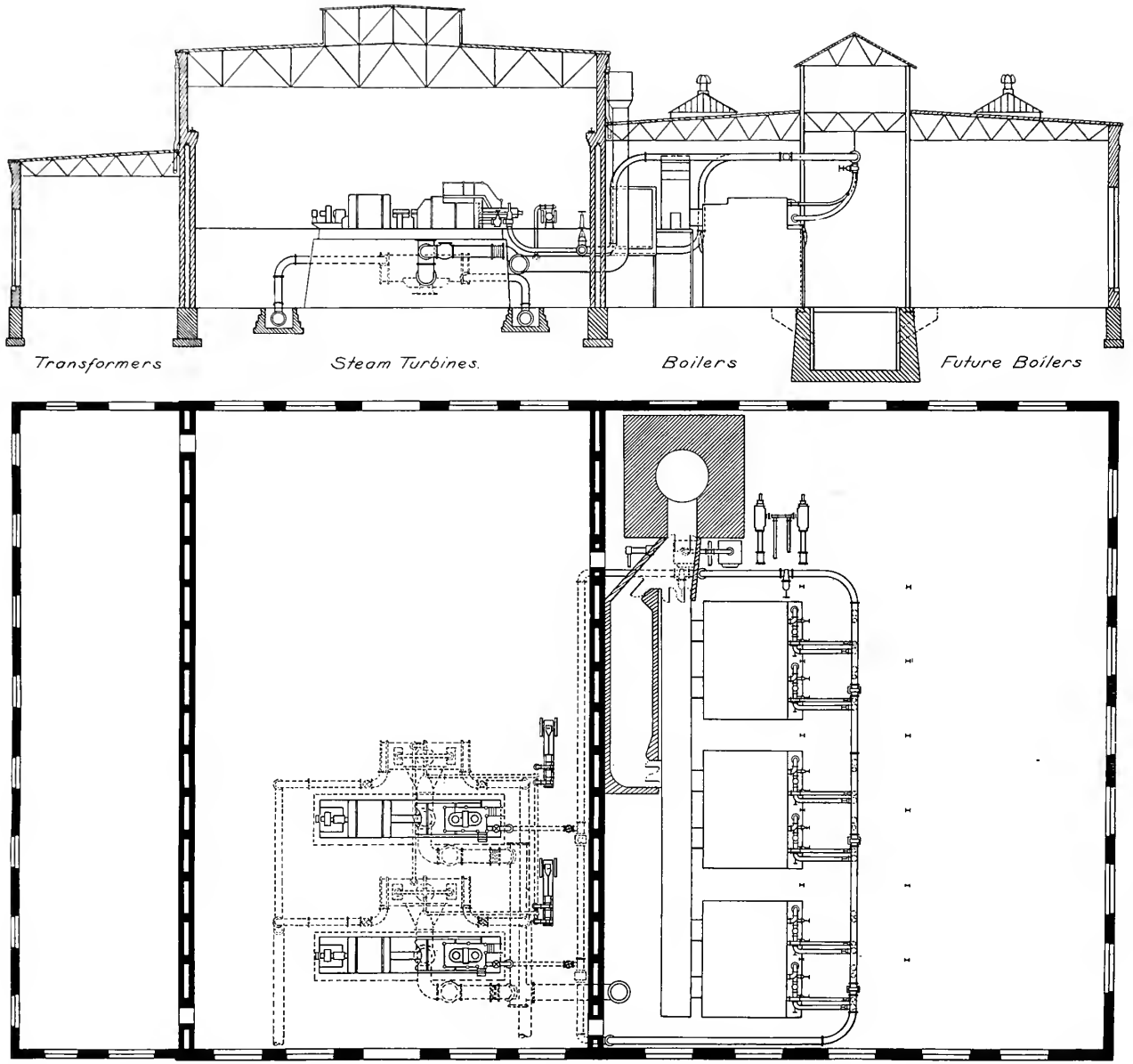
On the same floor are located rotary convertors, which supply direct current for the railway in the vicinity of the power house, exciting generators for energizing the fields of the main generators, and dry vacuum pumps which constitute a part of the condensing equipment for the steam turbines. The remainder of the condensing equipment is located in the basement or first story of the generator room.

The condensing plant is of the high vacuum type and consists of surface condensers, condensed water pumps and the dry vacuum pumps, each steam turbine having a separate and complete condensing equipment of its own. Cooling water for the condensers is supplied by motor driven pumps which are located a short distance away from the power plant on the bank of a stream, which gives an ample supply of fresh water.

As the steam turbines require no oil for internal lubrication, the condensed steam from them is free from foreign matter, and is therefore suitable for feeding into the boilers and being again converted into steam. Pumps are provided under each condenser for taking this condensation and discharging it to a storage tank which is combined with an open feed water heater. This heater and hot well is the beginning of the feed water system, and is supplimented by a fuel economizer, duplicate boiler feed pumps, and the feed water piping. As the only fresh water obtainable in the vicinity of the power station carries with it some scale-forming minerals which would form an incrustation on the inside of the boilers, it is necessary to treat the water. This treat-

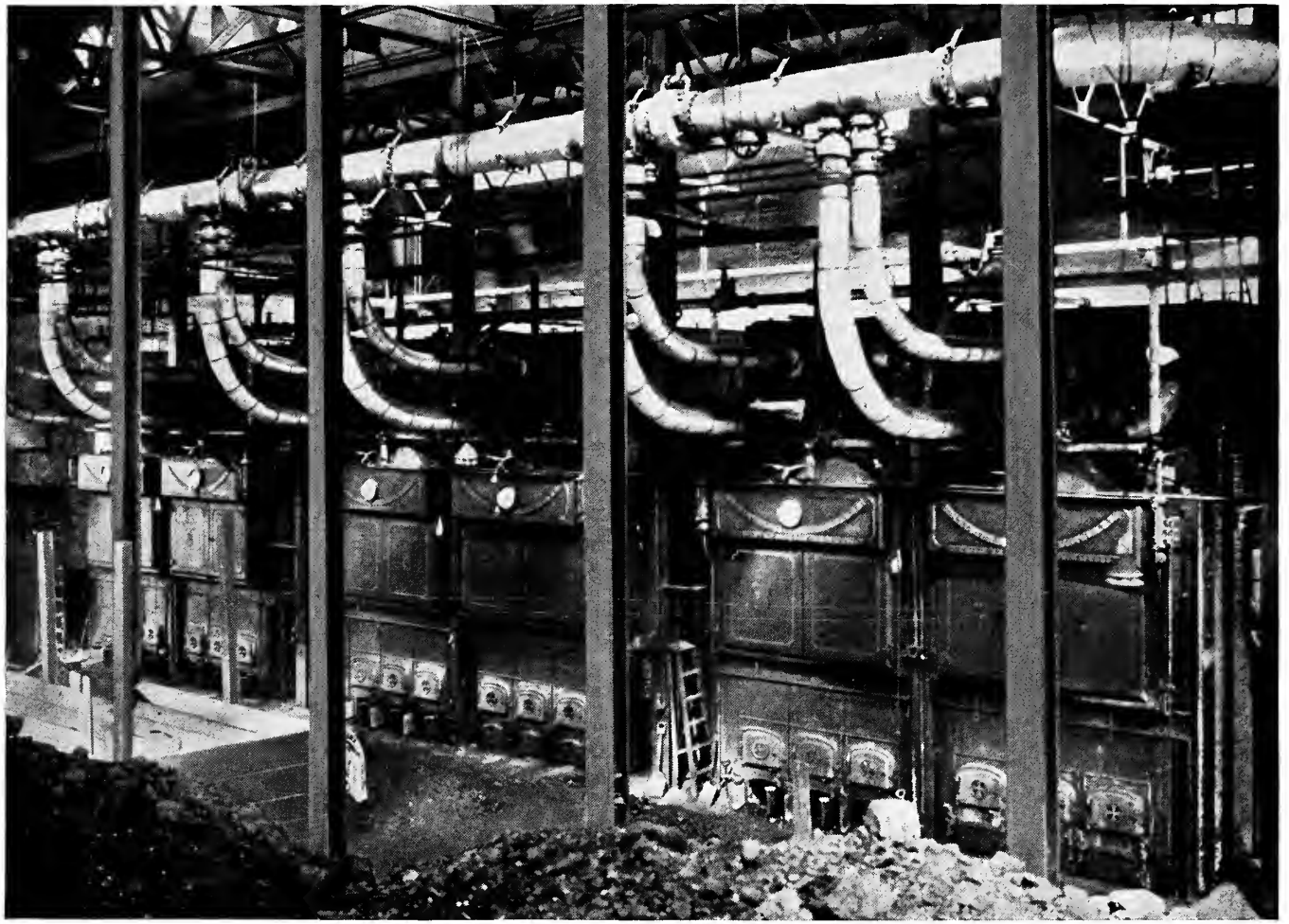


POWER PLANT. Rochester, Syracuse & Eastern Railway, Lyons, N. Y.



PLAN AND SECTION OF POWER PLANT.

Rochester, Syracuse & Eastern Railway, Lyons, N. Y.



BOILER HOUSE.

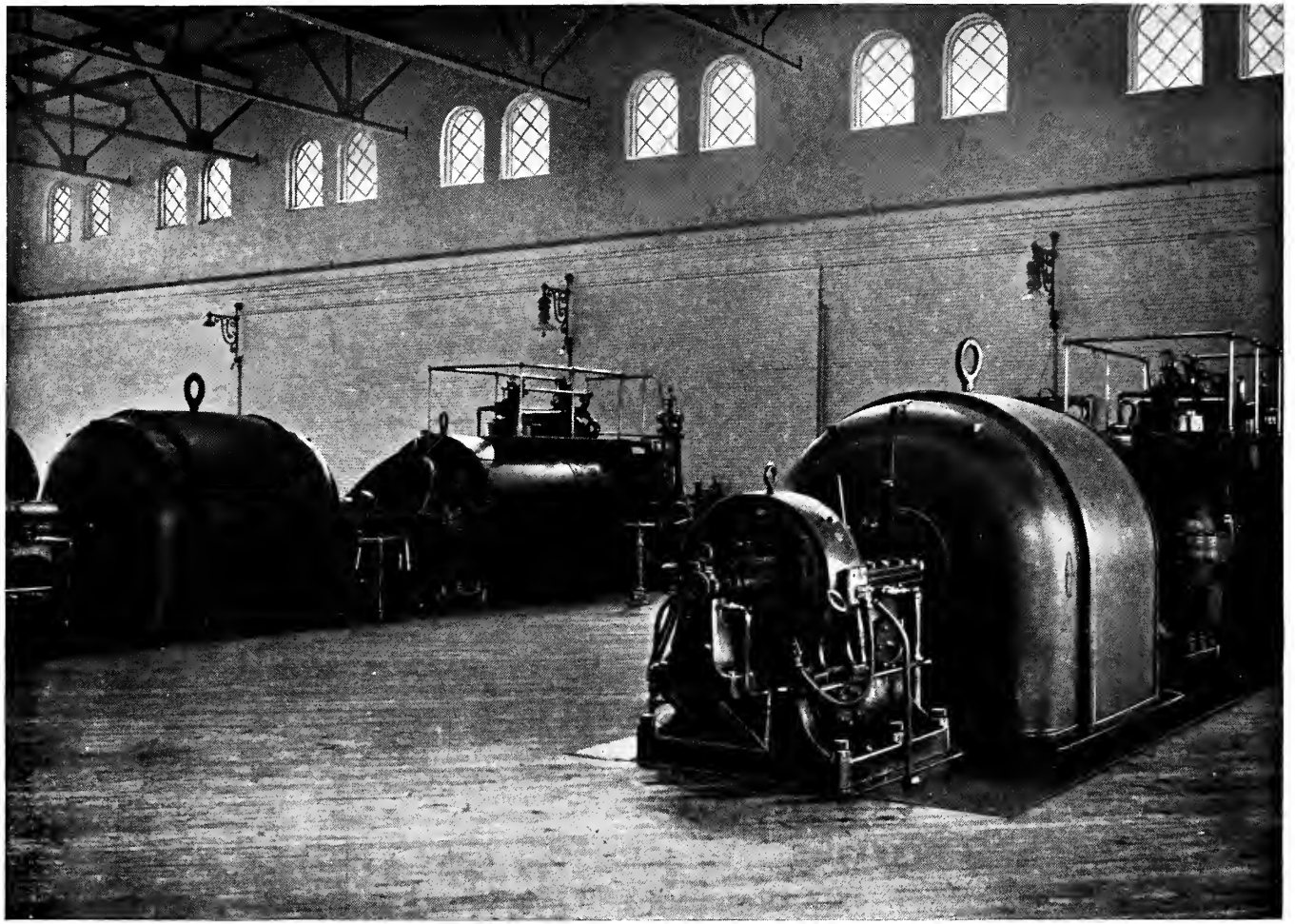
Rochester, Syracuse & Eastern Railway, Lyons, N. Y.

ment takes place at the top of the feed water heater, in a steam chamber whose interior is provided with a series of cast iron plates that intercept the fresh water admitted automatically. Steam is conducted to the chamber from the exhaust of the various steam driven auxiliaries. The water, finely divided in passing over the plates, takes up the heat in the steam, precipitating its impurities on the plates, which are occasionally withdrawn and cleaned. The hot water falls from the plates to the bottom of the chamber, where it mixes with the clean water discharged from the condensers, and is ready to be pumped to the boilers. To maintain the continuity of purification, two heaters were installed side by side and arranged to run separately or together, so that one can be cleaned while the other is in operation. As the boiler feed pumps are situated, the hot water flows to them by gravity, thence forced through the fuel economizer, where additional heat is acquired, and then passes to the boilers.

The boiler feed pumps are two in number, each large enough for the demands of the entire plant. There is, therefore, always a relay in case of necessary repairs on the one in operation. The boilers do not depend upon one course of feed water piping, because it is so arranged that water can be obtained from two different directions.

The boilers which supply the steam for this plant are of the water tube type set in three batteries of two each. They are fitted with steam superheaters, which superheat the steam by the hot gases on their passage through the boiler. These gases on leaving the boilers enter a sheet steel flue arranged along the backs of them, and by the side of the economizer. This flue is so arranged that by traveling in one direction the gases will pass through the economizer and to the chimney and by a system of dampers the gases are made to reverse their direction of flow and travel direct to the chimney, thus giving opportunity to clean or make repairs on economizer or its setting.

A damper is also provided at the entrance to the chimney for the purpose of regulating the draft to suit the working conditions of steam pressure and coal.



TURBO-GENERATING UNITS.

Rochester, Syracuse & Eastern Railway, Lyons, N. Y.

FLETCHER PAPER COMPANY, ALPENA, MICHIGAN.

The first work of this organization for the Fletcher Paper Company was in connection with a paper mill having two 112" Fourdrinier Machines and a daily capacity of forty tons of high grade sulphite wrapping paper. The raw material was largely Mitscherlich Sulphite Fibre produced in the fibre mill already in operation.

Since the installation of this paper mill, two more plants have been planned for this Company; a ground wood pulp plant with attendant power development, and a paper mill with one cylinder machine of a capacity of 10 tons daily of heavy lining papers and boards, the raw material for which is largely the refuse or screenings of the pulp plant and sulphite fibre mill already mentioned.

The paper mill plant is located across the street from the sulphite fibre plant and so arranged that raw fibre is handled by conveyor direct to the beating engines.

The ground wood plant is situated at a water power site about four miles up the river and the pulp is delivered to the paper mill by railroad.

The paper mill plant is quite the usual arrangement for 2 Fourdrinier machines in one building, with beating and Jordan engines, and necessary chests and driving mechanism in a building across the wet end of the machine building and at right angles to it. The engine and boiler plant for furnishing the power of the paper mill is located at the inside angle made by beating and machine buildings.

The machine building is one story, with machines on the ground level and pits in the rear in which are arranged the driving trains for the machines.

The beating building is two stories in height. The beating and Jordan engines are on the upper floor with the usual line shafting, chests, pumps and accessories to the beating department on the ground floor.

The finishing and shipping departments are also all on the level of the car floor where shipping tracks are arranged.

The ground wood pulp mill is a fair example of a compact and economic arrangement for a small production.

The power development has a hydraulic head of 20 feet. The grinder room forms a part of the dam and only short wheel cases are required. Three units for grinders and one for the screens and wet machines are arranged—the grinder units consisting each of one pair of horizontal turbines direct connected to two grinders.

The wood room is above the dam and the prepared wood sluiced to a tank in the grinder room.

The pulp is delivered by gravity to the stock tank and pumped to screens from which the flow is by gravity to the wet machines. The plant has a capacity of between 20 and 30 tons (dry weight) daily.

The paper and ground wood plants are of usual mill construction, masonry foundations, brick walls,

PAPER MILL.

Fletcher Paper Company, Alpena, Michigan.

steel and wood construction, with concrete floors in wet portions.

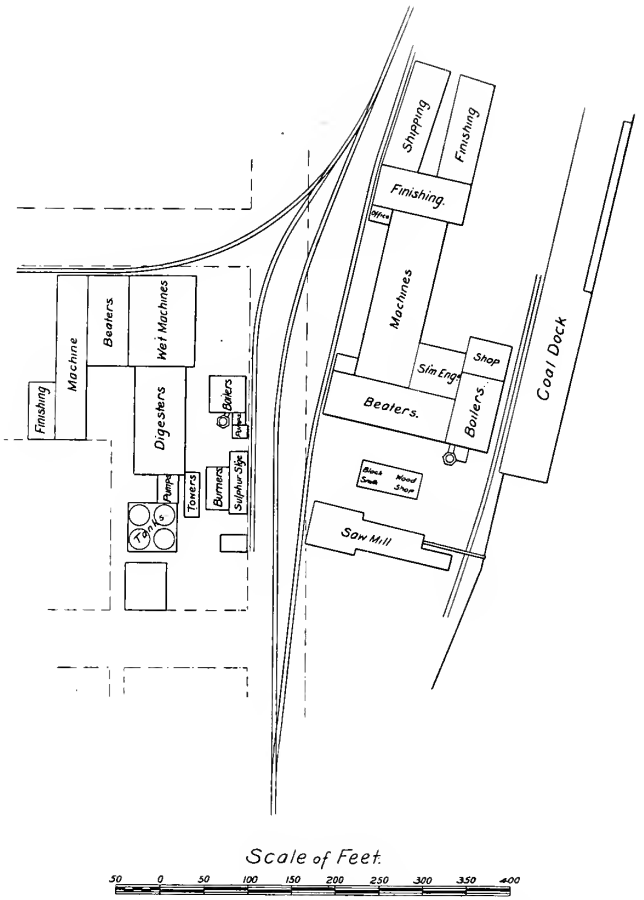
The board mill for utilizing screenings is arranged as an extension to the sulphite fibre plant, from which its raw material is largely obtained. The power, except for the paper machine, is derived from the main line shaft of the sulphite plant, extended into the beating department.

The property lines show that the available space for this plant was fully utilized.

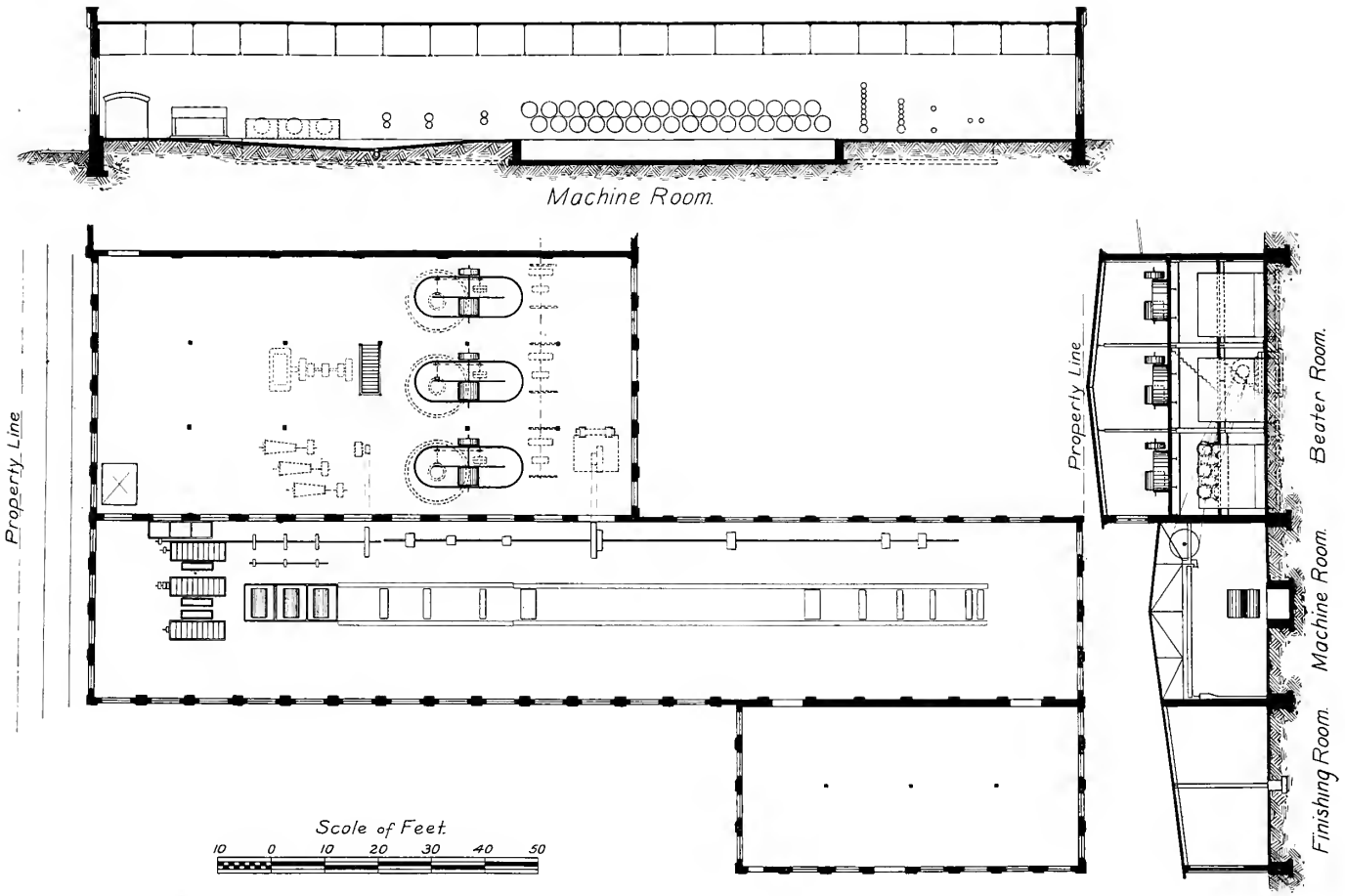
The Beating department has abundant room for storage of raw material on the level of the beating engines, and the stock is delivered from beating engines direct through Jordans to machine chests below.

No unnecessary expense was incurred, yet the plant is a good example of its type, and the arrangement, construction and equipment are first class for the purpose intended. The buildings are entirely of reinforced concrete and steel framing, except the finishing building, which is of slow burning wood inside construction with concrete walls. The machine building is one story, running the entire length of the available space and is roofed on steel trusses, carrying the back line shafting, as well as a light crane running the length of the building.

Broke and trimmings are returned to the beaters by elevator.

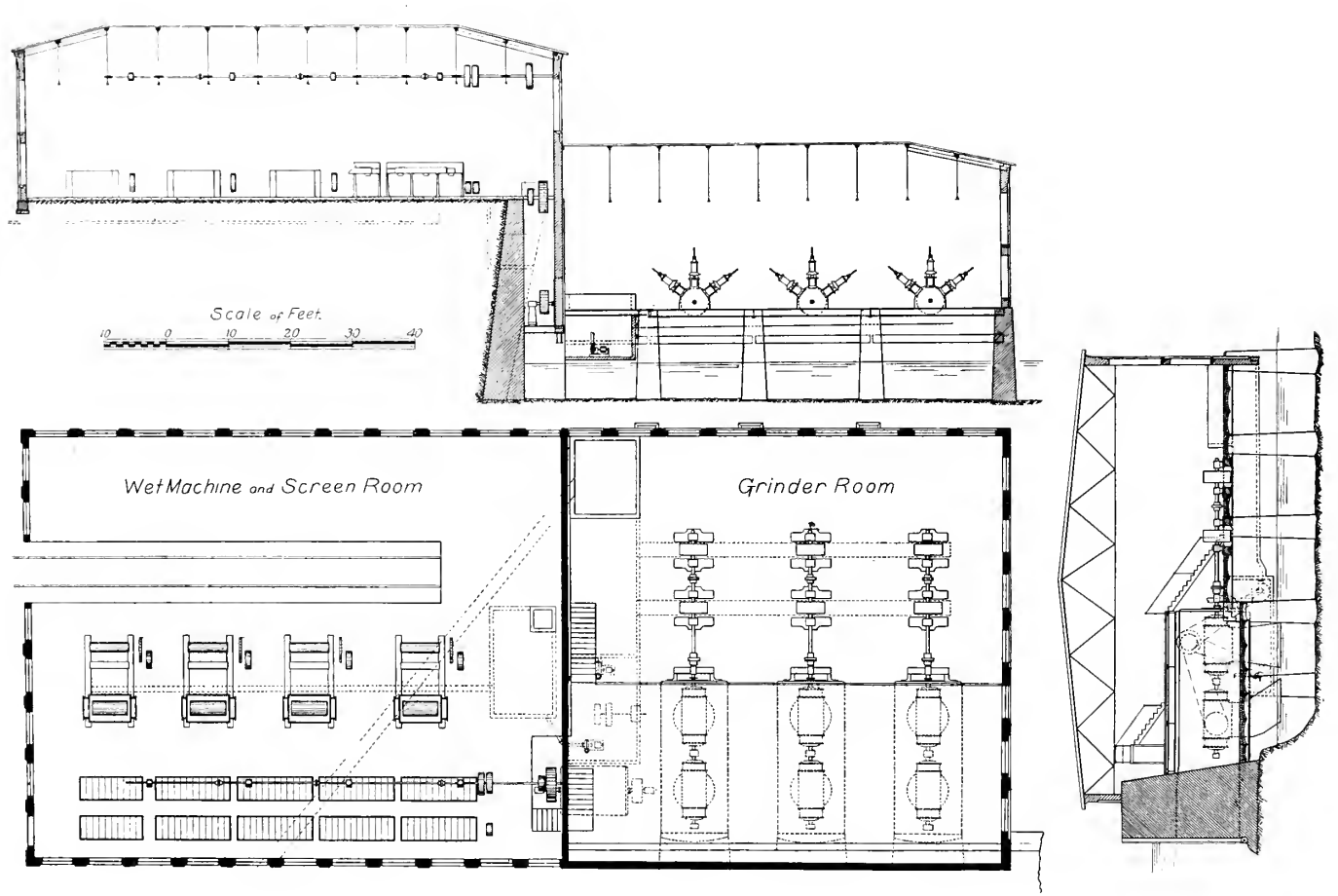


GENERAL ARRANGEMENT OF PAPER AND SULPHITE MILLS.
Fletcher Paper Company, Alpena, Mich.



ARRANGEMENT OF SCREENING PAPER MILL.

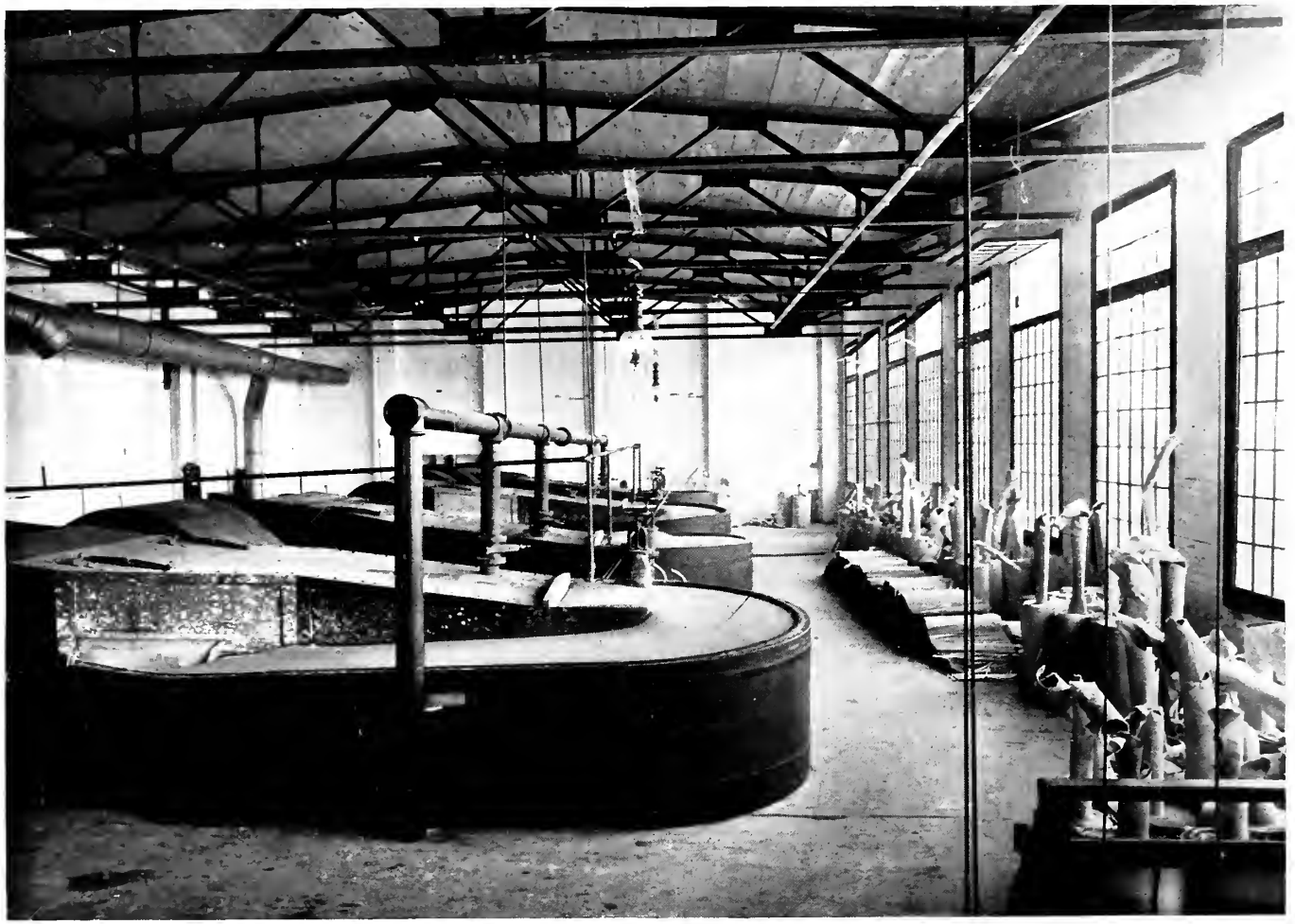
Fletcher Paper Company, Alpena, Mich.



ARRANGEMENT OF GROUND WOOD PULP MILL.

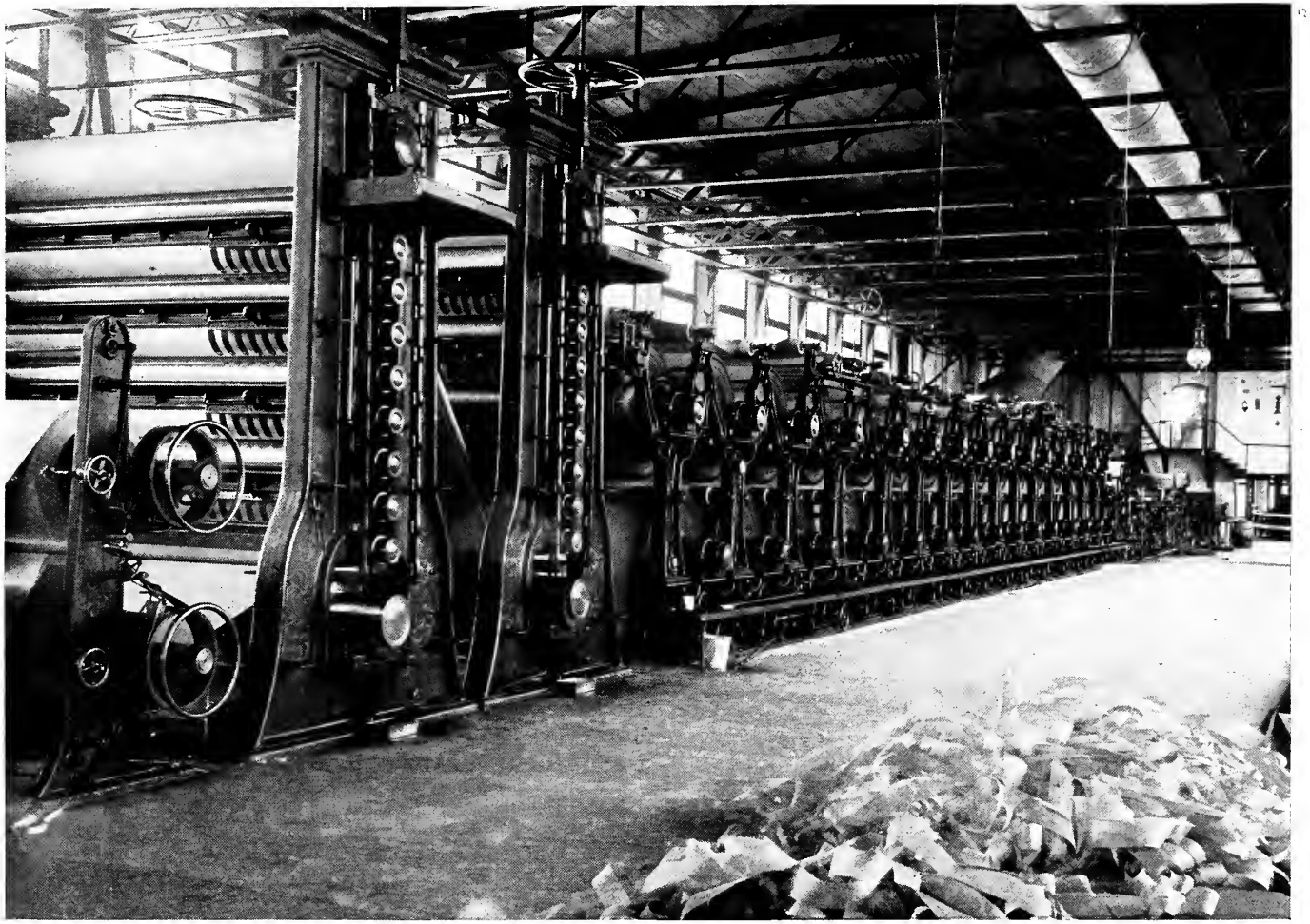
Fletcher Paper Company, Alpena, Mich.

GROUND WOOD PULP MILL FROM DAM. Fletcher Paper Company, Alpena, Mich.



BEATING ENGINE ROOM.

Fletcher Paper Company, Alpena, Mich.



MACHINE ROOM.

Fletcher Paper Company, Alpena, Mich.

THE J. & J. ROGERS COMPANY, AUSABLE FORKS, N. Y.

The mill is located on the north fork of the Ausable River, about three-fourths of a mile below the sulphite mill owned by the same company. The receiving and shipping facilities are excellent, a spur of the Delaware and Hudson Railroad running to the mill, so that all supplies are delivered at the plant without rehandling, and the output is placed directly from the finishing room into the cars. The coal supply is also received by the same road.

The hydraulic and water supply advantages are very great. At the sulphite mill is a dam, and a penstock carries the water to the paper mill, which is at a much lower level, thus obtaining a very high head and great power at low cost. The water supply for paper making comes from the same source. The site upon which the mill is built is convenient to the village of Ausable Forks, and is also well adapted as to topography and soil for the construction of mill, power development, etc.

It is a three-machine mill, with a small ground wood mill. Only two machines are now installed, one 136-inch Fourdrinier and one 90-inch cylinder and Fourdrinier combined. The general arrangement of the plant comprises grinder room, beater room, machine room, finishing room, and boiler house.

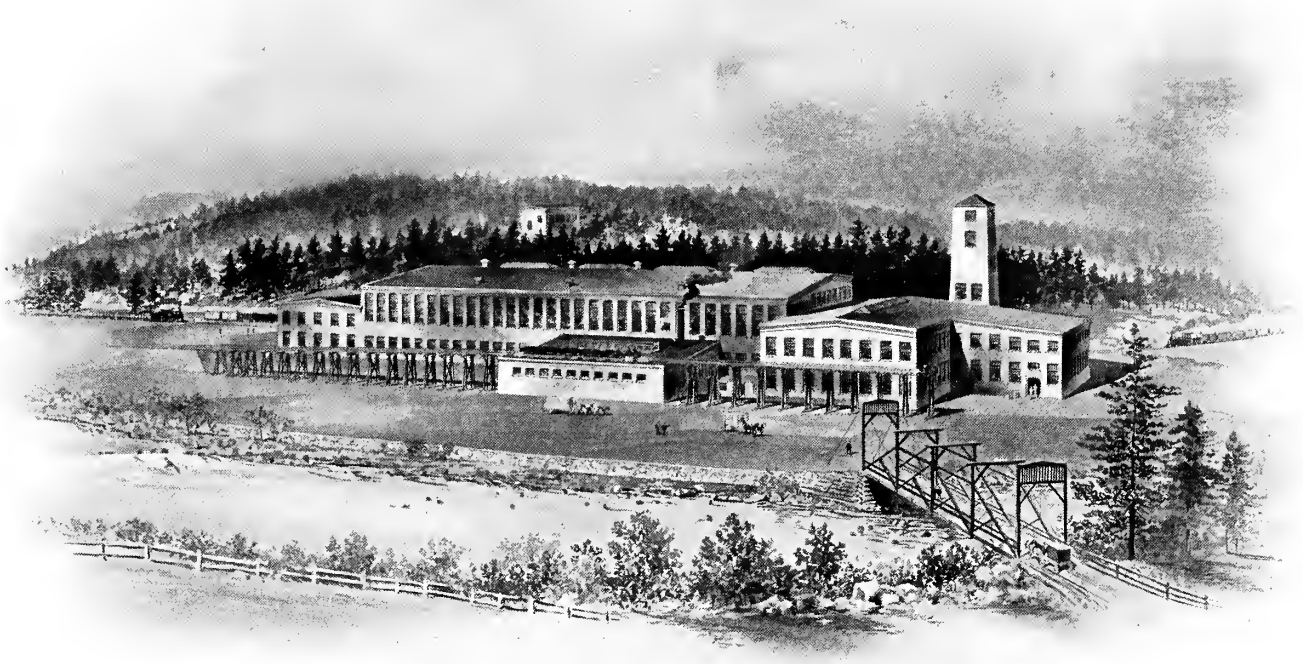
In the beater room are six 1,800-pound beaters and two Jordans, with the accessory pumps, chests, etc. The beaters, Jordans, chests, and pumps are driven from main line in the basement, the main line being driven by a water wheel, transmitting through a rope drive of the "American" type. Arrangements are made to drive the line electrically in case of emergency.

The machines are engine driven and direct connected to variable speed transmission. The machine room is arranged for the installation of another large machine, and is so designed that the change will require but the building of the machine and engine foundations, the main floor system remaining practically unchanged.

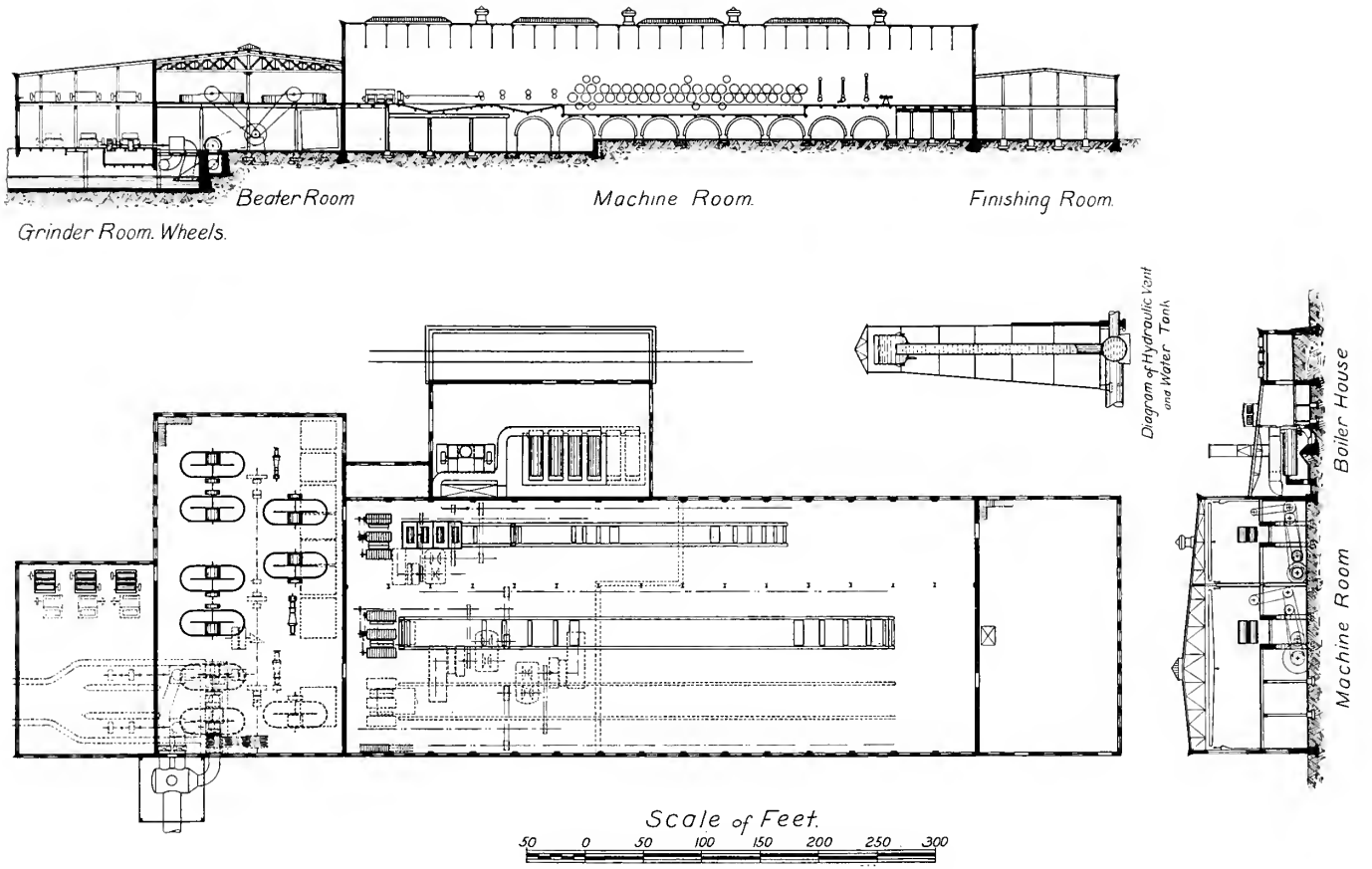
The ground wood mill has two direct connected grinders and a stock pit of concrete and steel, placed directly under them. The pumps are placed in a pit and receive the supply by gravity. Diaphragm screens are used for the ground wood stock. A cutting-off saw and splitter is provided, no barkers being necessary, as the wood comes peeled in 4-foot lengths.

The filtered water used for process purposes runs under pressure from the penstock to a gravity filter plant, located on the hill (capacity 2,500,000 gallons per day), the filtered water flowing by gravity to the mill. The elevators of the plant are electrically driven. The boiler plant consists of four 150 horsepower units return tubular boilers, with space for future extension. The coal is dumped direct from railroad cars into the coal pocket, which adjoins the boiler house.

Two boiler feed pumps are installed; one motor



J. & J. ROGERS CO., AUSABLE FORKS, N. Y.

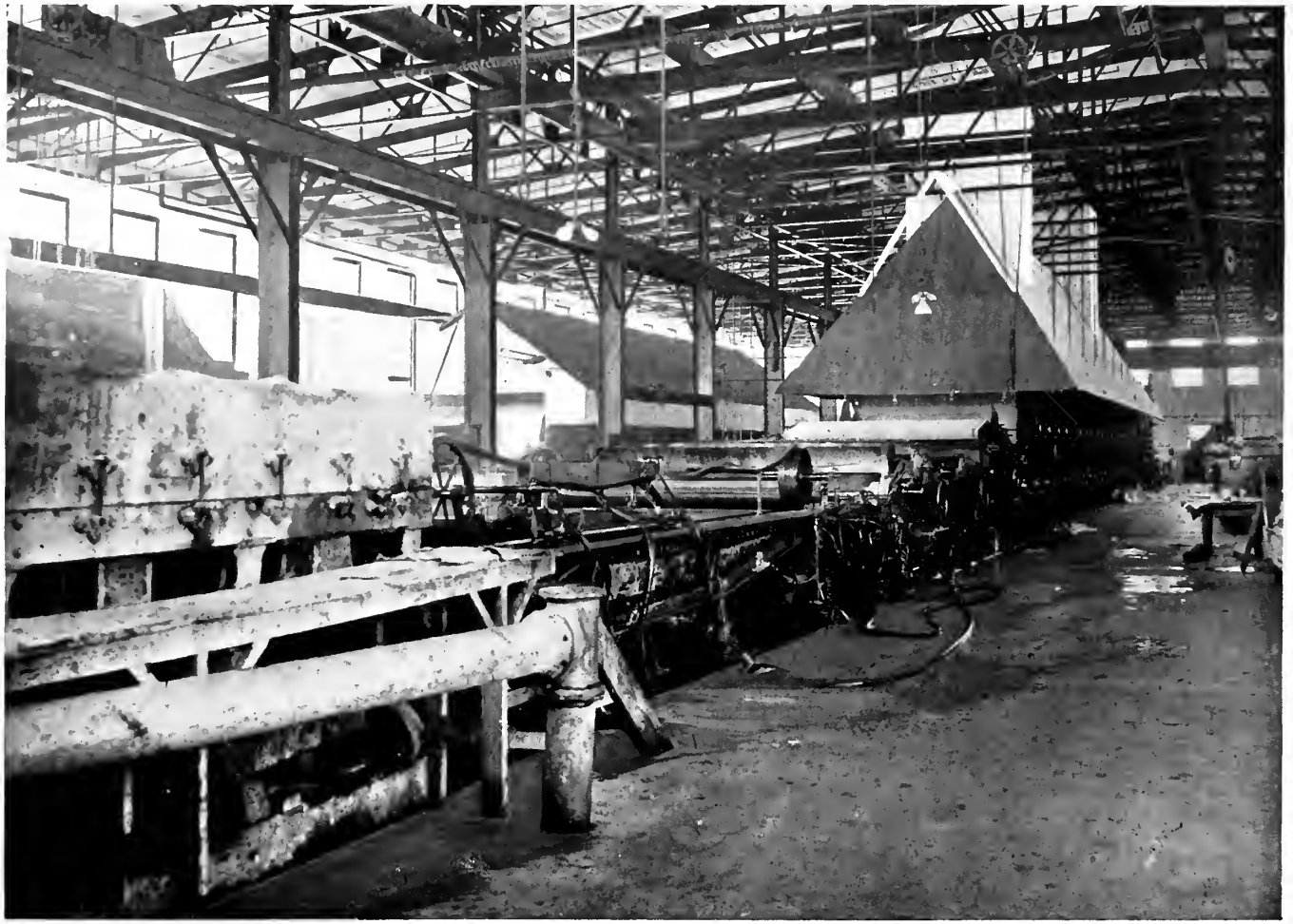


PLAN AND SECTIONS.

J. & J. Rogers Company, Ausable Forks, N. Y.

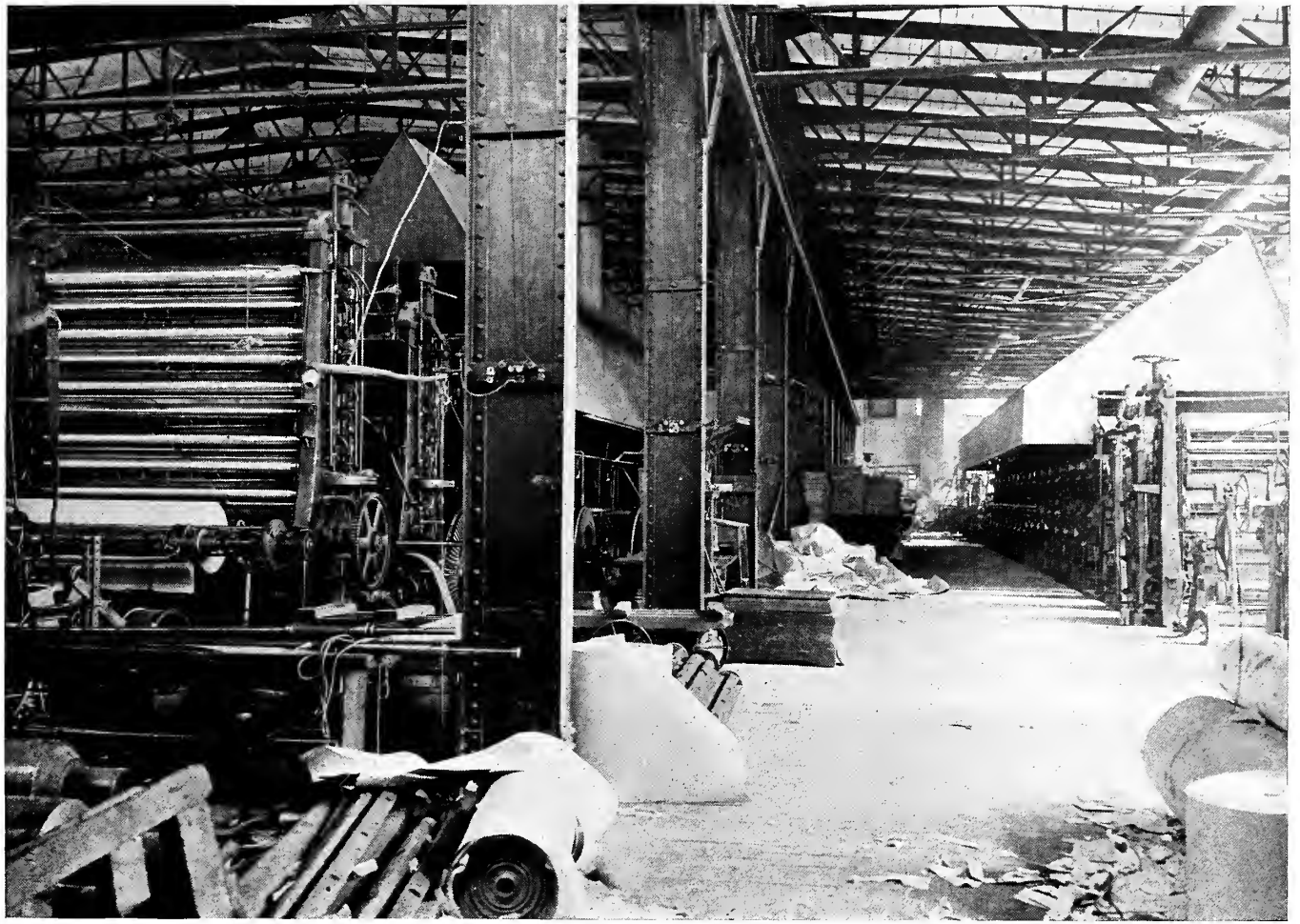
BEATING ENGINE ROOM.

J. & J. Rogers Company, Ausable Forks, N. Y.



MACHINE ROOM.

J. & J. Rogers Company, Ausable Forks, N. Y.



MACHINE ROOM.

J. & J. Rogers Company, Ausable Forks, N. Y.

driven pump for regular run, and one steam pump for emergency. An open feed water heater, with combined cast iron hot well, heats the water before it is pumped into the economizer. Two single cylinder non-condensing engines operate the two paper machines.

The hydraulic power water is carried to the wheels by means of a penstock, 7 feet 6 inches diameter, running from the dam at the sulphite mill to a steel forebay at the paper mill, from which the units are supplied with water by 54 inch penstocks. Relief is provided for the penstock by a 48 inch vent pipe at the forebay, which is supported by a steel tower and extends above the elevation of the crest of the dam. As a protection against overflow, a steel tank is built around the top of the vent pipe, at such relative elevation as will provide storage for fire protection purposes. The head obtained is about 100 feet, and required the extension of the tail-race a few hundred feet down the river.

The wheels are of the horizontal type, single runner, and all are in the beater room basement. One unit drives the main line of the beater room through a rope drive. The two grinders are direct connected to one of the units, the remaining unit being direct connected to a 450 K. W., A. C. generator, which is to be used as a generator when power is lacking at other plants up the river owned by the company, by reason of anchor ice or other trouble. Emergency arrangements are made so that the beater line water wheel may be disconnected, the generator connected to the main beater line through a rope drive, and run as a motor, driving the beater room line, receiving its power from generators up the river. This arrangement allows great flexibility, and almost any condition of power may be met satisfactorily.

The construction of the plant is of concrete foundations, brick walls, wooden roofs, with gravel roofing. The floor system of the finishing room, grinder room, and the dry end of the machine room is of slow burning mill construction. The beater room and wet end of the machine room are of steel construction with reinforced concrete floors. Concrete basement floors are used. The beater and machine room roofs are trussed. All window and door lintels are of steel, and steel is used in construction of wheel supports and floor over wheel pit and tail-race. Cast iron plates and caps, door sills, and guards were used. The plant was designed with view of reducing the insurance rates, and follows most approved practice.

A complete system of automatic sprinklers is installed, also hydrant system with 1,000-gallon Underwriter pump. The hydrant and sprinkler system is connected with the penstock, as well as with the pump.

FINISHING ROOM.

J. & J. Rogers Company, Ausable Forks, N. Y.

KALAMAZOO PAPER COMPANY, KALAMAZOO, MICH.

This plant is an example of a modern mill in which old paper is largely used in manufacturing high-grade book and writing papers. The success of the company in their old plant led them to consider extending it by additions, but it was finally decided to build a new two-machine plant adjacent to the old one, and to so plan the power and office buildings as to provide for the needs of both. This decision was due to the proposed addition of quite different lines of product, and the advisability of keeping them completely separated, and also to the fact that the old plant was not well adapted to the new products.

The usual L shape of paper mills is adhered to; the machine room forms one main wing, the beating engine room, pulp store-room, and preparing buildings, the other wing, at right angles to machine room.

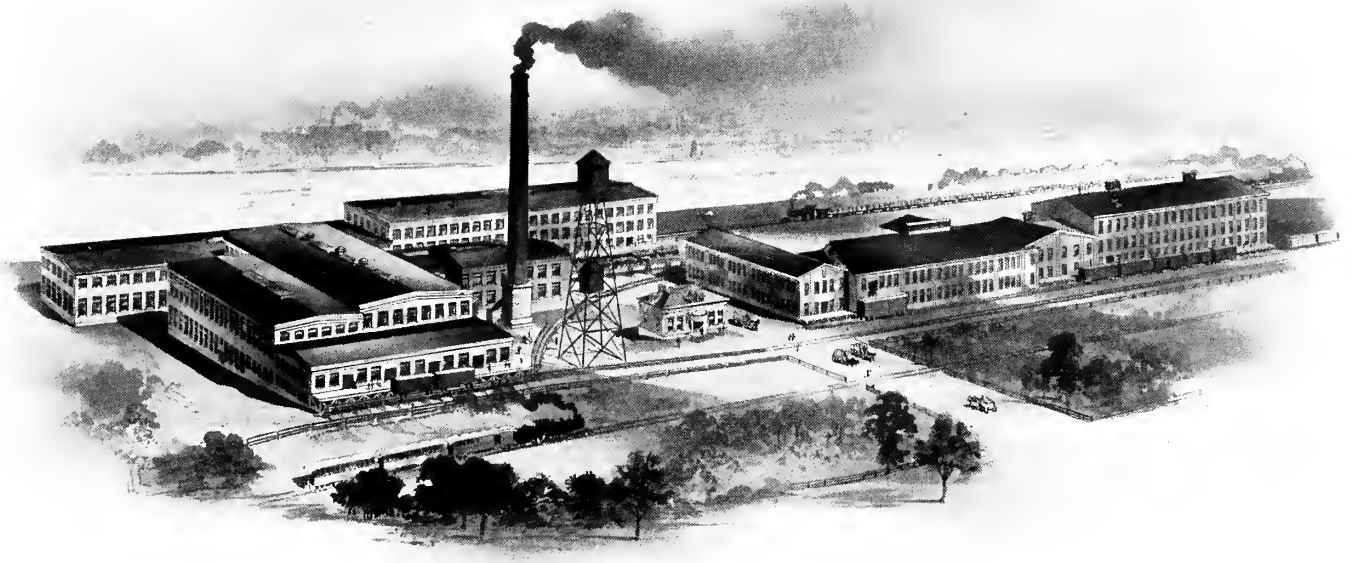
The super-calender room is parallel to and adjoins the machine room, thus affording direct service in and out from the machines or the shipping building with paper in storage. This design also facilitates the main power feature of the plant; *the concentration of all the steam engines of the plant in one spot* under the wet end of the paper machines, adjacent to the boiler house and in such location that each can be belted direct to the main line governing its work. Electrical distribution of all the power of this plant was considered, but it seemed that nothing was to be gained by it, with the bulk of the power requirements so located that there was no distribution by long lines of shafting and gearing. (Compare with the all electrical distribution shown in the layout of other plants in this book, where the conditions have made such installations desirable.)

The utilization of the lower or ground floor of the machine building has always been a problem to the paper mill engineer. In Europe, he has generally considered the advantages of having the beating engines and machines on the same level to be more than offset by the extra cost of the machine building, if the machines are raised to the second story.

The conditions of operation are different for each mill and product, but, in the case of the Kalamazoo Plant, all were agreed that the machines must be on the same level as the beating engines and calenders, and, therefore, that a high ground floor under the machines was necessary. The slope of the land was suited to the placing of the highest story at the wet end of machines and under beating engines, where the elevation was essential for flow of stock, to chests and drainers.

Except paper machines, calenders, and beating engine department, the plant is electrically driven, with an arrangement providing for an independent direct connected unit for this work when required.

The paper and rag stocks are taken by elevator from storage to top floor, and there delivered to the sorting tables, and thence in usual manner through the rag preparing machines. Four 8 by 24 foot



KALAMAZOO PAPER CO., KALAMAZOO, MICH.—NEW AND OLD MILLS.

rotary bleach boilers are used to cook both paper and rag stock. In the rotary building also are tanks and chests for the manufacture and storage of size and liquor.

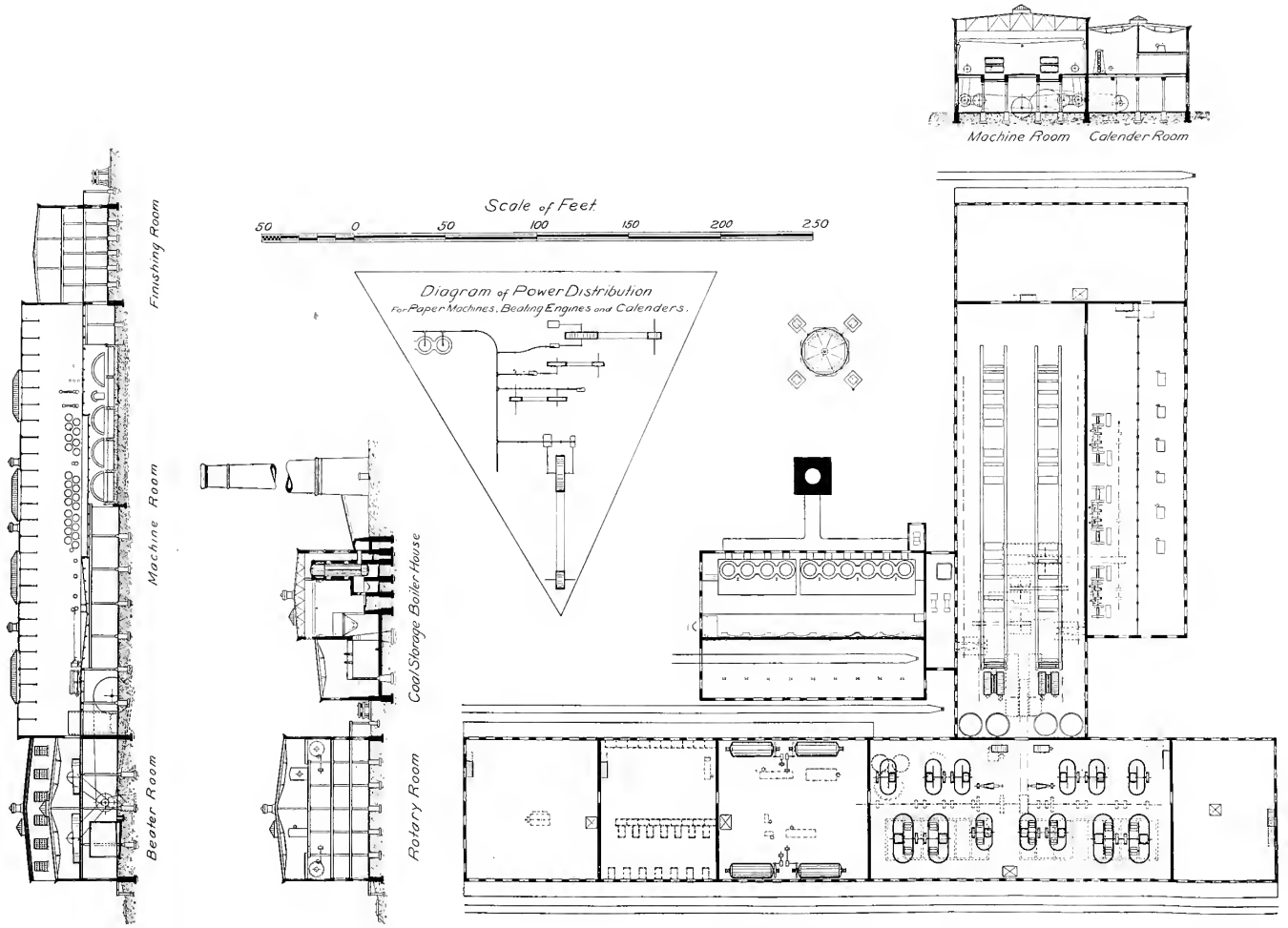
The wood pulp stock is stored in the building adjoining the beater room on the east. In the beater room are seven 1,500 pound beaters, four 1,800 pound washers, two 1,500 pound washers, two Jordans, screens, and sand settlers. On the ground floor are reinforced concrete drainers and stuff chests, accessory pumps, etc. Reinforced concrete offered many advantages for the construction of the drainers and chests.

In the machine room are two 130-inch Fourdrinier machines, which are driven by steam. The engines belt to the constant line of each machine, which is direct connected to a variable speed transmission, through which the power is transmitted to the variable line, direct connected to the variable shaft of the transmission. From the constant line are driven the stuff and suction pumps and Jordan and machine chests. On the ground floor are reinforced concrete chests, which extend up through the main floor and are open at top. This room also contains the filters and two 18 by 36-inch engines, non-condensing, for the paper machines, a 22 by 44 by 48-inch and an 18 by 36 by 42 inch cross-compound condensing engine, driving the beater and calender lines respectively. This concentration of engines under wet end of paper machines makes possible a very compact distribution of power and the utilization of space not ordinarily of value.

In the building where the calenders are installed provision has been made for a future installation. Over the calenders is a five ton trolley running the length of the room. The cutters are located in a gallery of the super-calender room. On the ground floor of this building are the roll grinders, repair shop, etc.

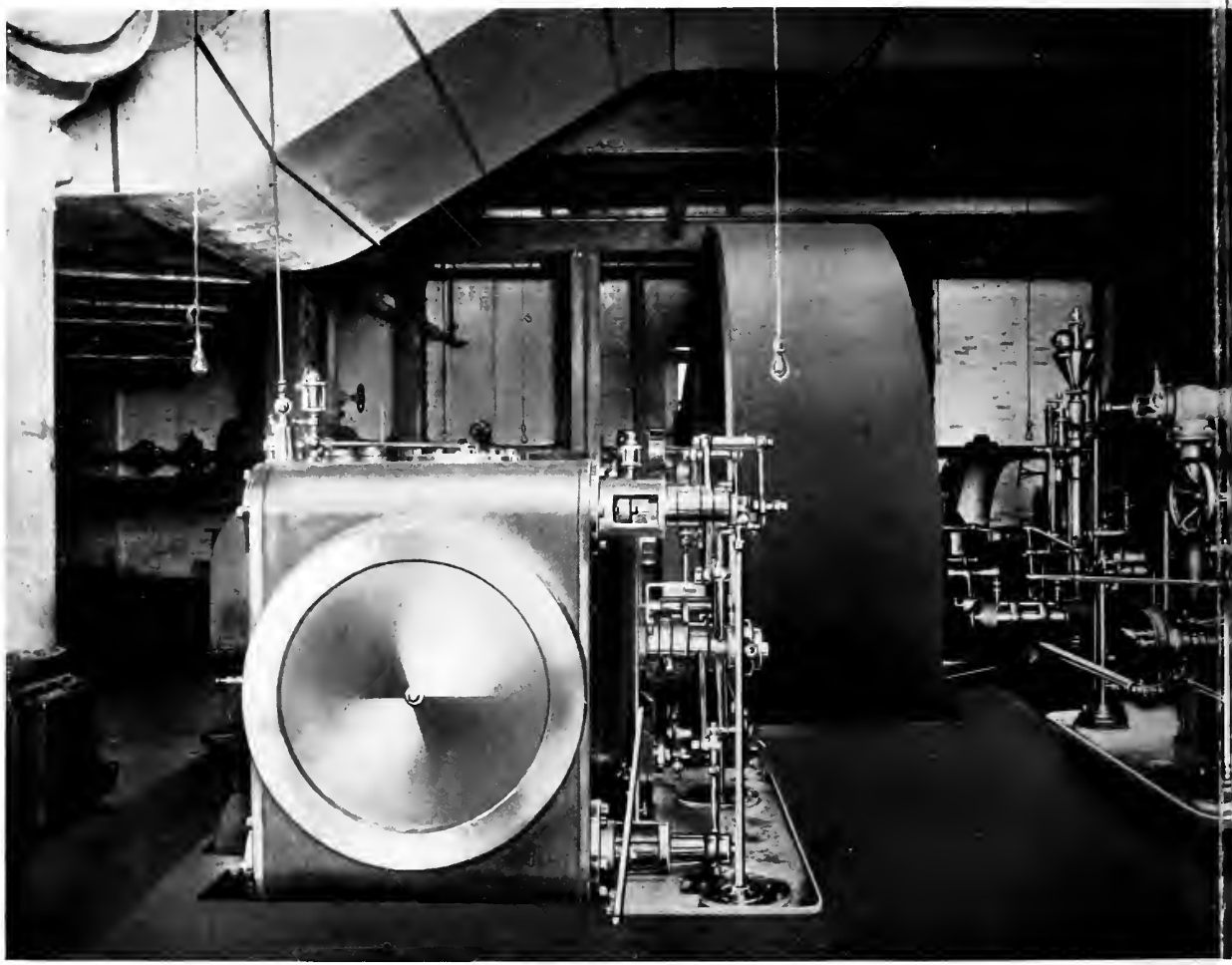
The water supply is pumped from the river and runs through gravity filters located on ground floor of the machine room. A 15,000 gallon storage tank is provided on a steel trestle, distributing the water to both No. 1 and No. 2 mills.

The boiler plant consists of ten 250 H. P. vertical water tube boilers in two batteries of six and four units. They generate steam under a pressure of 150 pounds. The boilers burn soft coal under natural draft. Steam is provided for the No. 2 mill, through a main in a tunnel. Coal is dumped from the car directly into the coal pocket, which adjoins, and forms part of the boiler house. A one ton crane running the length of the boiler house transfers the coal into the stoker hoppers. The ashes are discharged into buckets in an ash tunnel, and are emptied into an ash hopper, discharging outside of the building.

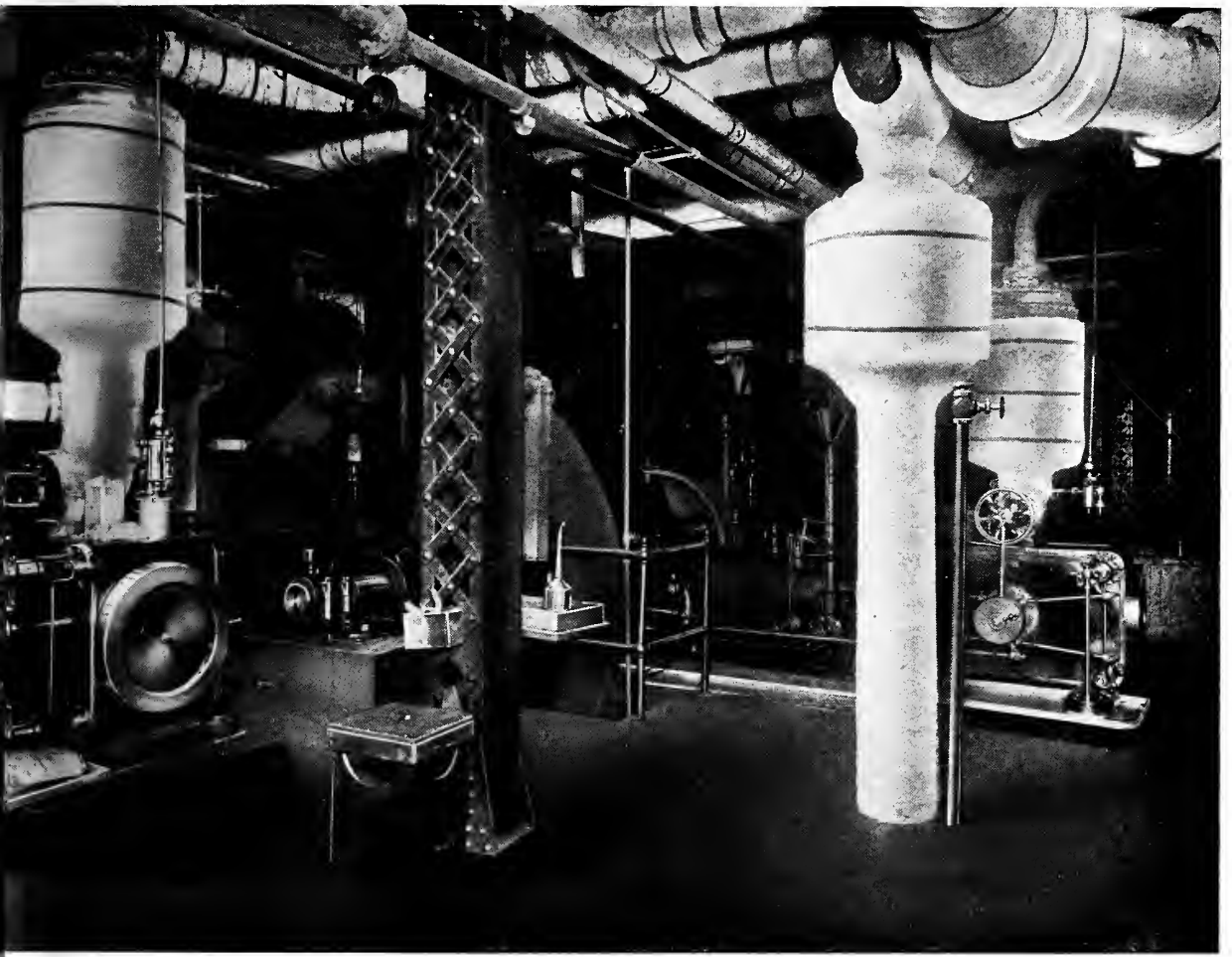


PLAN AND SECTIONS.

Kalamazoo Paper Company, Kalamazoo, Mich.



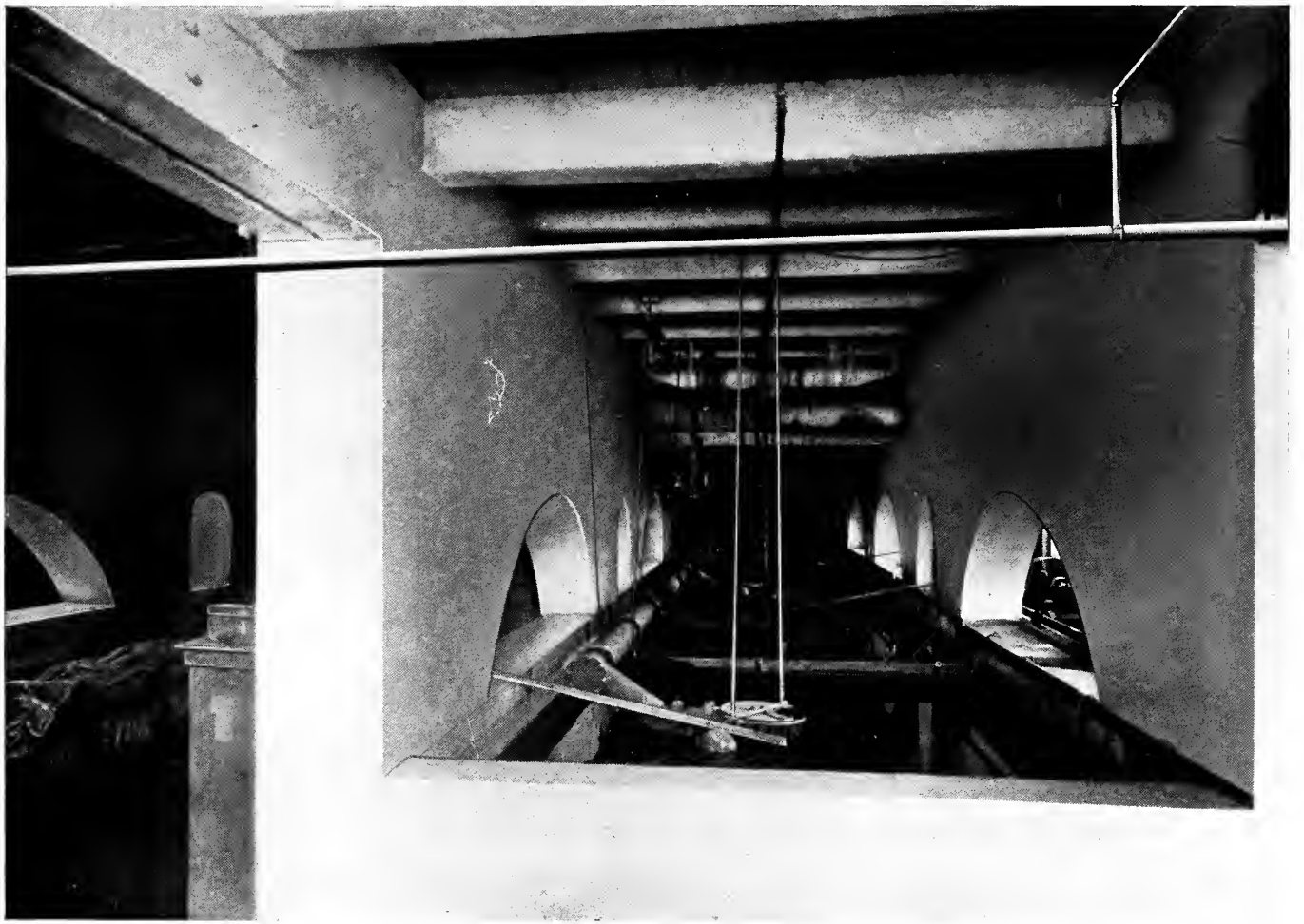
ENGINE ROOM UNDER MACHINES.



Kalamazoo Paper Company, Kalamazoo, Mich.

BOILER ROOM.

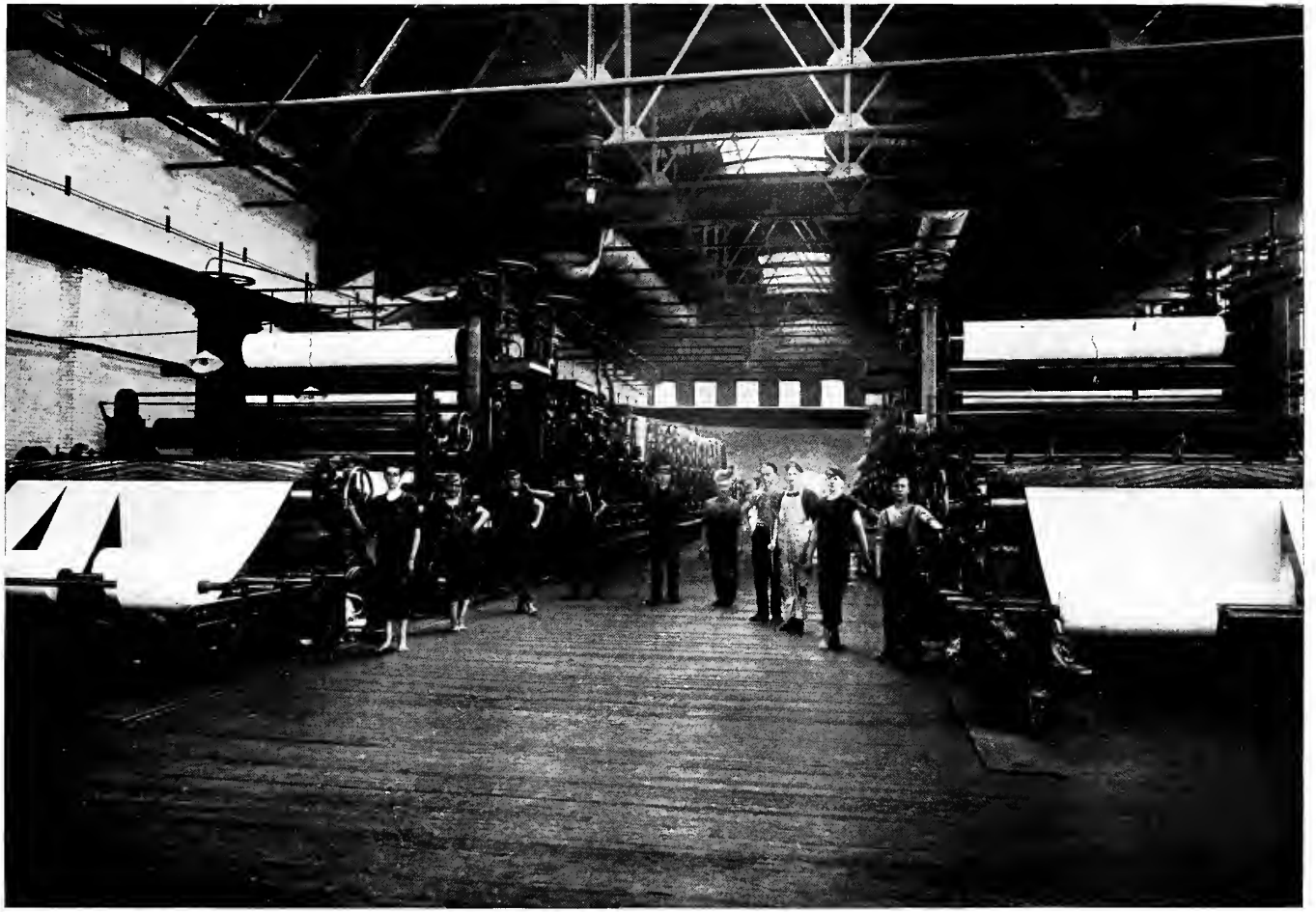
Kalamazoo Paper Company, Kalamazoo, Mich.



FILTER BEDS ARRANGED IN MACHINE FOUNDATIONS. Kalamazoo Paper Company, Kalamazoo, Mich.

BEATING ENGINE ROOM.

Kalamazoo Paper Company, Kalamazoo, Mich.



MACHINE ROOM.

Kalamazoo Paper Company, Kalamazoo, Mich.

INDUSTRIAL OFFICES

The administration department of an industrial plant should be housed in quarters convenient for the proper handling of the affairs of the company, and as each office organization has its own methods, the design of proper office arrangements is usually a problem special to the requirements of the particular case.

We present three typical examples from among many offices designed by this organization. (A) The office of the Kalamazoo Paper Company at Kalamazoo, Mich., U. S. A. (B) The office of the Goulds Mfg. Co., at Seneca Falls, N. Y., U. S. A. (C) The office of the Wall Paper Mfrs., Ltd., Ingress Abbey Mills, at Greenhithe, Kent, England.

(A) The Kalamazoo office building is simple and convenient, and contains one story with cellar and unfinished attic for storage.

The entrance hall at the centre runs through the building and divides the accounting room on the right from the private offices on the left.

(B) The requirements of the Goulds Mfg. Co. led to the adoption of a two-story building.

The central court and fireproof vault extend up through the second story and form the main feature of the design.

This central court forms the waiting room and general clerk's office on the ground floor, and the second floor is occupied only by a gallery, which allows good overhead light into the main floor. The filing of correspondence is convenient from this general office into the fireproof vault.

The private offices are grouped about the court and vault and are all exceptionally well lighted.

The treatment is of simple Colonial, with brick walls and wood interior. The interior finish is in quartered oak in principal offices and ash elsewhere.

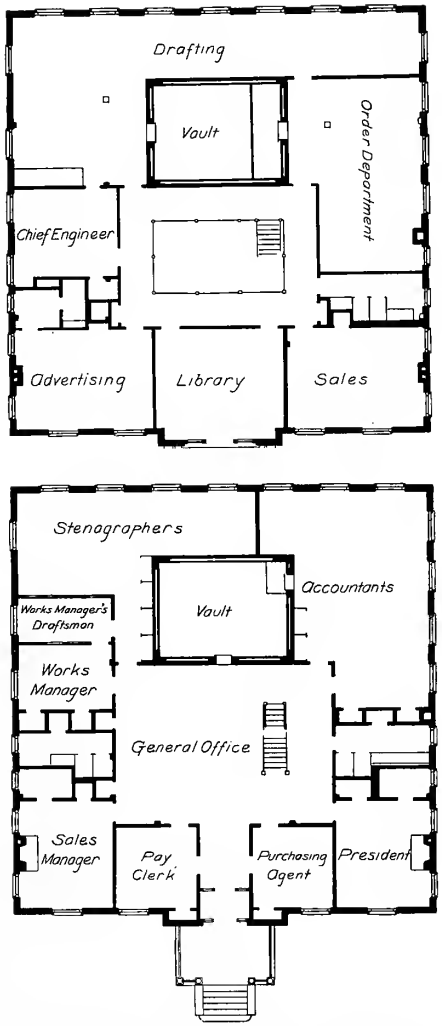
(C) The Administration Building of the Ingress Abbey Mills of the Wall Paper Manufacturers, Ltd., is illustrated in plan and section herewith. The main floor of the plant is about 20 feet above ground and the entrance to the plant is off an elevated footpath crossing the property parallel with the Finishing Building.

The main floor of the offices is on the same level, and an intermediate story was thus available. The entrance from the footpath is by bridge across the railway tracks and along the end of the Finishing Building. A timekeeper's and watchman's office is at the entrance.

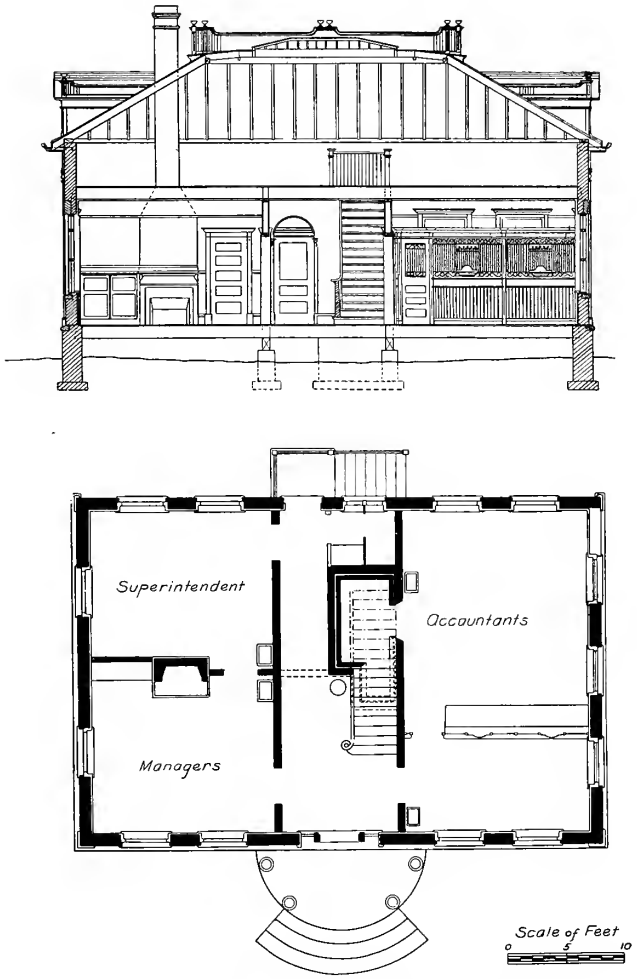
On the third floor are the general clerks and stenographers, as well as offices of Manager, Superintendent, and Director. The fireproof vault on this floor is devoted to filing correspondence.

The second floor is devoted to quarters for statistics and library, accountants, and a lunch-room for heads of departments.

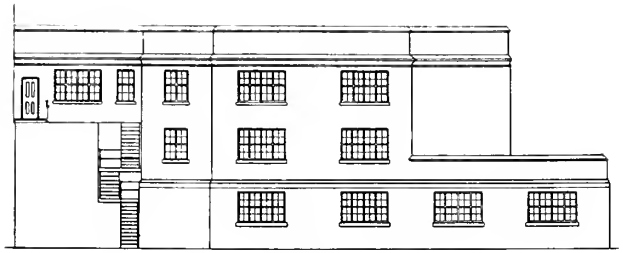
The ground floor has kitchen and general lunch-room for employees, also chief engineer's and chemist's quarters and laboratories.



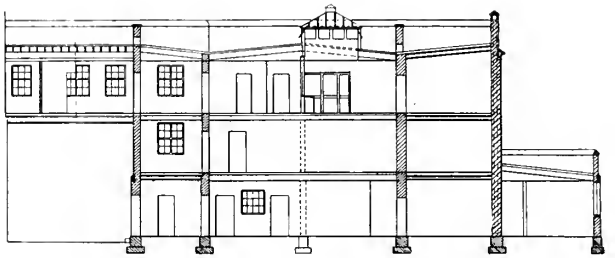
ARRANGEMENT OF OFFICE BUILDING.
Goulds Manufacturing Company, Seneca Falls, N. Y.



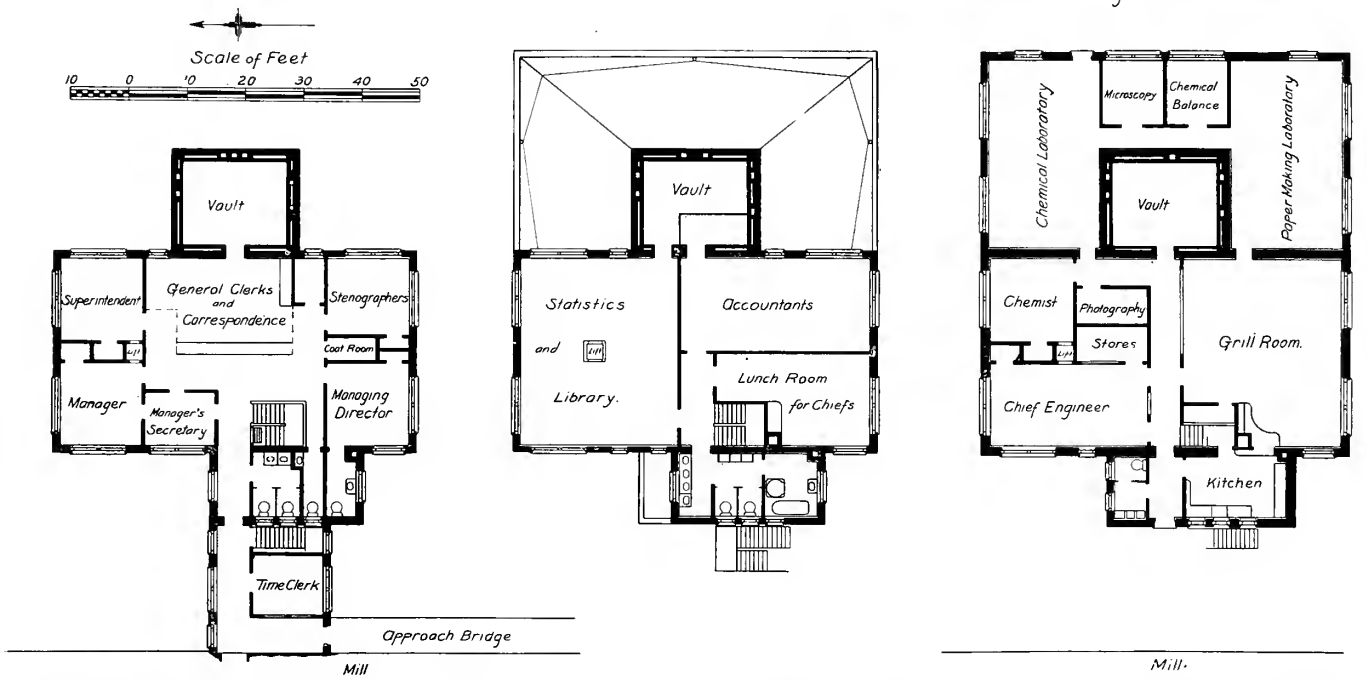
ARRANGEMENT OF OFFICE BUILDING.
Kalamazoo Paper Company, Kalamazoo, Mich.



South Elevation



Section Looking North



ARRANGEMENT OF OFFICE BUILDING. Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe, Kent, England.

OFFICE BUILDING.

Goulds Manufacturing Company, Seneca Falls, N. Y.

OFFICE BUILDING.

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RING OILING HANGER
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SHAFTING COUPLINGS HANGERS
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ROPE WHEELS FLY WHEELS
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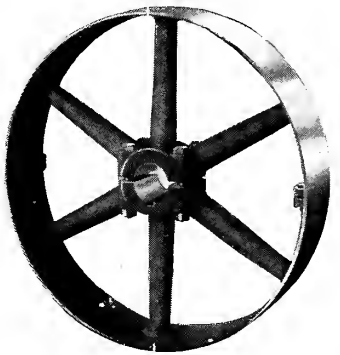

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Beating Engines	Jordan Engines	Arm Dusters	Horizontal Stuff Chests
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WHEAT'S Rag Dusters

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Paper Machines Exported in Past Three Years

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2—156"	PAPETERIE DE LA SEINE	Paris, France
2—142"	OJI SEISHI KAISHA	Tomakomai, Japan
1—156"	PAPETERIE DE LA SEINE (second order)	Paris, France
1—124"	ANGLO-NEWFOUNDLAND DEVELOPMENT CO.	Grand Falls, Newfoundland
1—110"	FROVIFORS AKTIEBOLAG	Frovifors, Sweden
1—110"	SOCIETE DES BOIS, PATES ET PAPIERS DU MIDI	St. Antoine, France
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2	MACHINES FOR CHINESE GOVERNMENT PAPER MILL	Hankow, China

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GOULD PAPER CO.	Lyons Falls, N. Y.
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OTHER DEVELOPMENTS
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We can refer to the following Paper Mills shown on the foregoing pages

WALL PAPER MFRS., LTD., GREENHITHE, KENT, ENGLAND . . . . . Pages 8 to 41
J. & J. ROGERS CO., AUSABLE FORKS, N. Y. . . . . Pages 130 to 137
MUNISING PAPER CO., MUNISING, MICH. . . . . Pages 72 to 85
KALAMAZOO PAPER CO., KALAMAZOO, MICH. . . . . Pages 138 to 147

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ENGINES FOR ALL CLASSES OF MANUFACTURING
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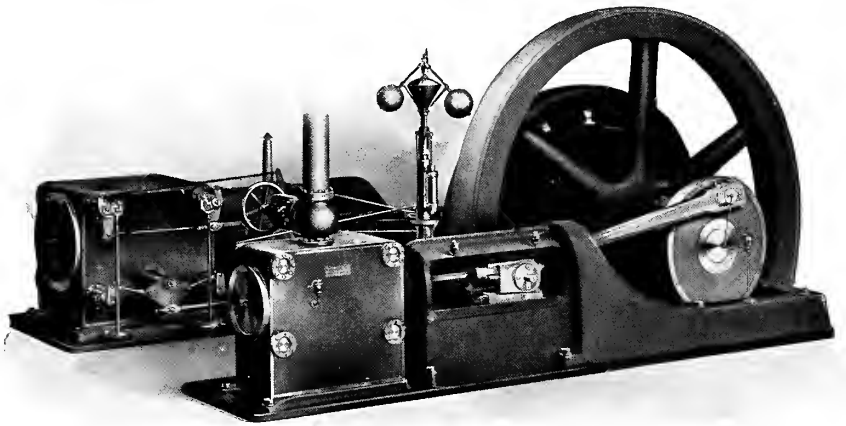

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HIGH-GRADE DIAPHRAGM SCREENS

INSTALLATIONS IN
WALL PAPER MFRS., GREENHITHE, KENT, ENGLAND
SEE FOREGOING PAGES, THIS BOOK
NUMBERS 8 TO 41

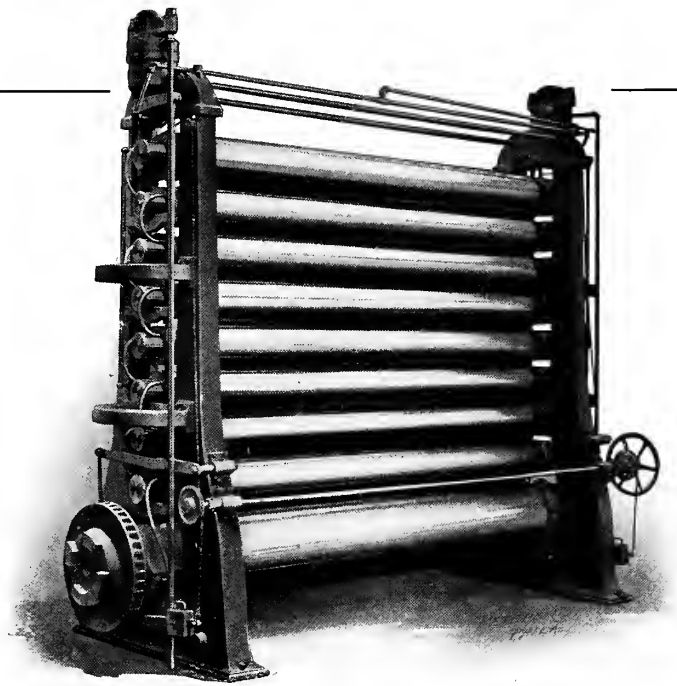
OUR ROLLS ARE INSTALLED IN

Wall Paper Mfrs., Ltd.
Greenhithe, Eng.
Pages 8-41.

Munising Paper Co.
Munising, Mich.
Pages 72-85.

Roanoke Rapids Paper Co.
Roanoke Rapids, N. C.
Pages 98-107.

B. D. Rising Paper Co.
Housatonic, Mass.
Pages 108-113.



OUR ROLLS ARE INSTALLED IN

Uncas Paper Co.
Norwich, Conn.
Pages 114-115.

Fletcher Paper Co.
Alpena, Mich.
Pages 122-129.

J. & J. Rogers Co.
Ausable Forks, N. Y.
Pages 130-137.

Kalamazoo Paper Co.
Kalamazoo, Mich.
Pages 138-147.

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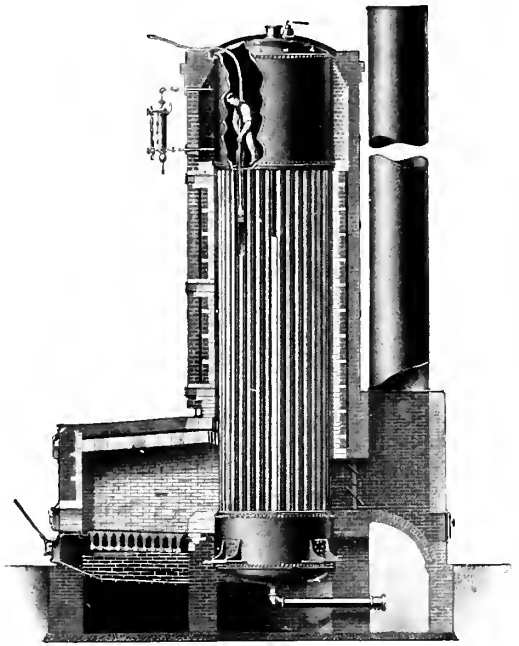
ROLL GRINDING MACHINES FOR PAPER MILLS

The Wickes Boiler Vertical Water Tube



EVER CLEANED A BOILER
KNOW HOW HARD IT IS
SKINNED YOUR ELBOWS
BARKED YOUR SHINS
BRUISED YOUR KNEES ?

TWO Manholes open. The Wickes Vertical Water Tube Safety Steam Boiler from top to bottom is open for cleaning. The cut shows position of man cleaning. Is it laborious compared with usual forms?

Besides it is safe, simple, durable, economical, and delivers absolutely dry steam.

See description of boiler in paper mills, pages 72 to 85; 122 to 129; 138 to 147, and ask us for complete list of paper mill users.

ASK FOR BULLETIN
SENT FREE

THE WICKES BOILER CO., Main Office and Works, Saginaw, Mich., U.S.A.

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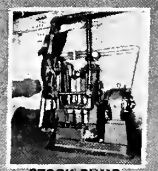
STOCK PUMP

PAPER MACHINE

WATER WHEEL GENERATORS

TRANSFORMERS

Electric-Motor Drive

is the accepted method of power application in all modern paper and pulp mills, also in many old ones. After years of careful study we have developed electric motors particularly for paper mill operation; we understand the conditions. We furnish electrical apparatus to operate your mill with individual motors or under the group system. Our apparatus is installed in the following plants described in this publication:

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Fletcher Paper Co. ..... Alpena, Mich.
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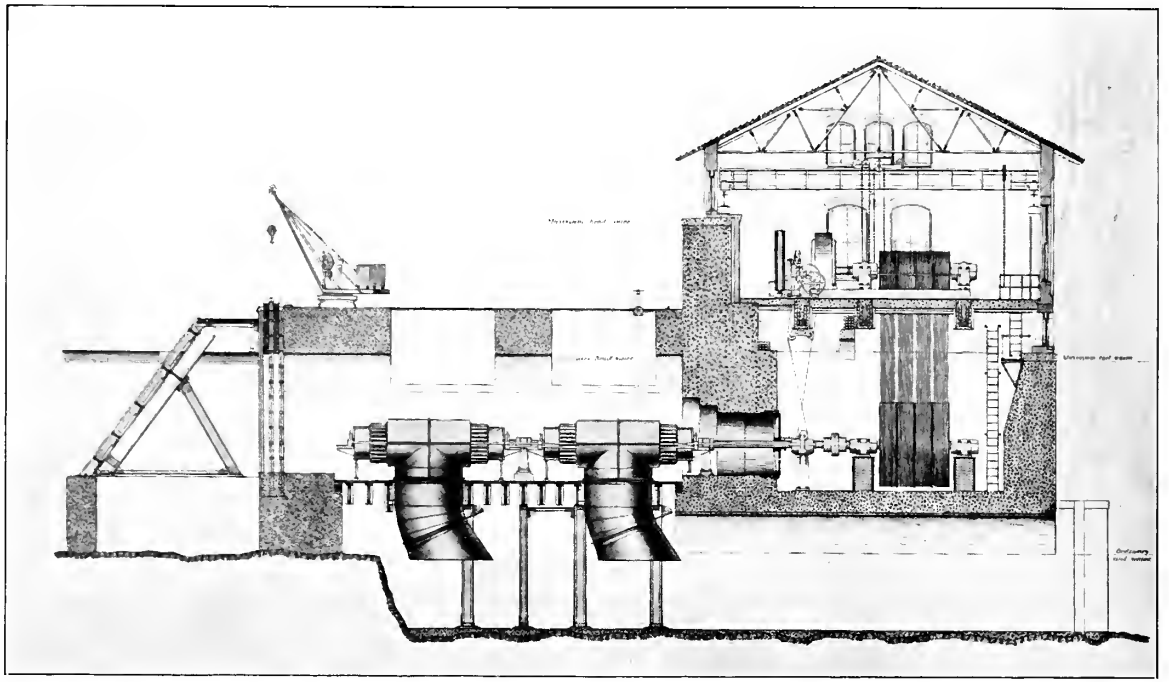

Cylinder and Wicket Gate Turbines on Vertical or Horizontal Shafts

Operating under all conditions with highest possible efficiency

Contracts taken for Complete Installations and Results Guaranteed

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THE SANDY HILL IRON AND BRASS CO.

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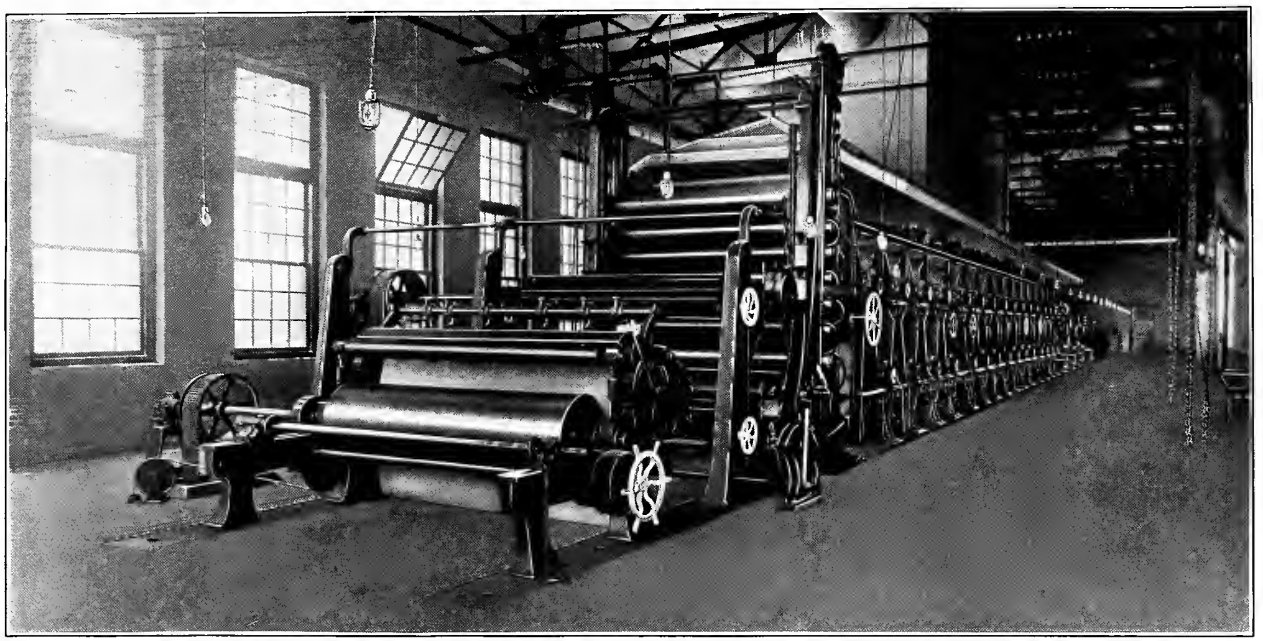
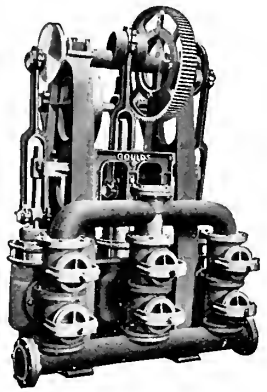
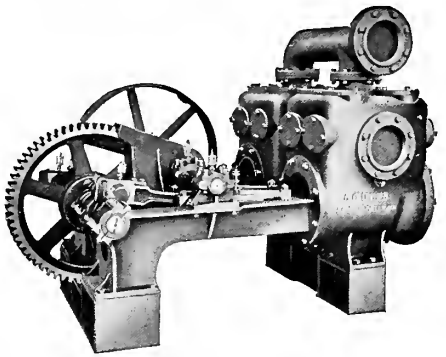


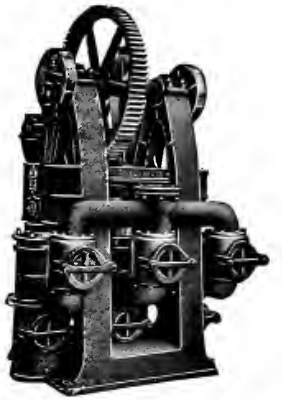
INSTALLATION OF A 90-INCH FOURDRINIER MACHINE—Iroquois Pulp and Paper Company, Thomson, N. Y.

HIGH SPEED FOURDRINIER PAPER MACHINES.

GOULDS







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FOR PAPER AND PULP MILLS

They are carefully designed with respect to ample and properly distributed weight, excellence of material and accuracy of workmanship. They will deliver stock in an unvarying and continuous flow when supplying paper machines. They run with far less power than Fan, Centrifugal or other types. Write us for catalogs.

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Branches: NEW YORK BOSTON PHILADELPHIA PITTSBURG CHICAGO
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ESTABLISHED 1875

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the world over in building

Paper Making Machines

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for

Paper and Pulp

Mills

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HAMILTON, OHIO, U. S. A.

LARGEST

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equipped

Electric Driven Plant

IN AMERICA

Seven 15-ton Electric

Cranes in constant use

All Machines

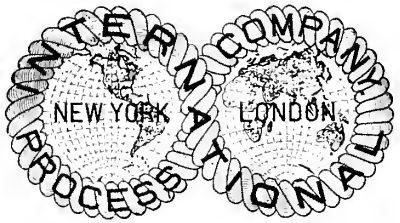
completely erected on cast iron levelling plates and

carefully inspected before shipment

OUR MACHINES ARE MONEY MAKERS

INTERNATIONAL PROCESS COMPANY

Temple Court Building, New York



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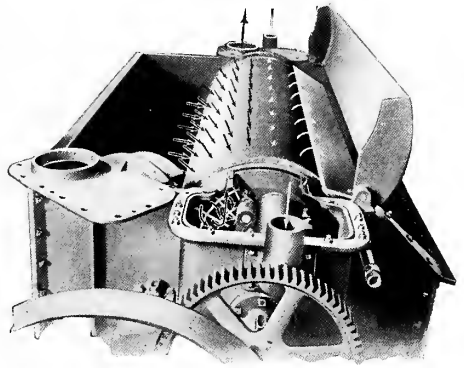
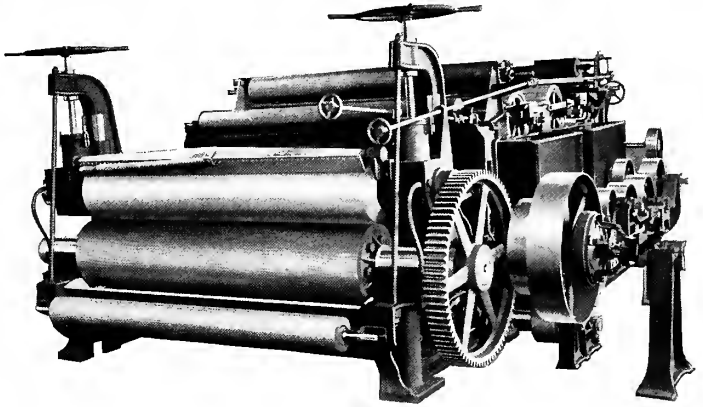
IMPROVED PULP and PAPER MACHINERY



PNEUMATIC SAVE-ALL



TWO-CYLINDER WET MACHINE

OUR Pulp and Paper Machinery has been invented, designed, built and demonstrated to accomplish radical improvements over previous types. AS EXAMPLES: Our Wet Machines, with auxiliary press rolls, are guaranteed to produce a larger output of better and drier laps and for less money than any other type on the market of the same size of cylinders. Our Pneumatic Save-Alls are reclaiming enormous values (over $1,000,000 a year) of pulp in uniform and perfect condition at a total cost of a few cents a ton, and doing this in many cases where all previous devices for saving had failed. These Save-Alls operate on an absolutely new principle, the fibre being drawn into a cylinder mold by suction and gravity only, and blown off, after thickening, onto a deflector with no rubbing or scraping of fibre or screen. The air currents are indicated in the illustration by arrows: White arrows indicate air pressure and black arrows indicate suction. These Save-Alls are absolutely guaranteed and, if properly installed, will save over 90% of all waste.

Specifications, prices and catalogues of Wet Machines, Pneumatic Save-Alls and Pulp Thickeners or Fellless Wet Machines, sent on request.

IMPROVED PAPER MACHINERY COMPANY

NASHUA, N. H., U. S. A.

The machinery built by this Company is built also in Canada from the same plans and specifications, and under the same personal direction by the SHERBROOKE MACHINERY CO., LTD., SHERBROOKE, P. Q.

ESTABLISHED 1837. INCORPORATED 1867.

RICE, BARTON & FALES,

MACHINE AND IRON CO.

CHARLES S. BARTON, Prest. & Treas.
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WORCESTER, MASS.

BUILDERS OF

Modern Fast Running and Heavy Fourdrinier and Cylinder Machines for Making Paper, and Drying Pulp.

- Double Drum Vertical Winders and Re-Winders
- Upright and Revolving Reels
- Large and Heavy Wet Machines
- Revolving Cutters and Layboys
- Hill Patent Diagonal Cutter, which can be equipped with Slitting Arrangement, and Reeling Off Bars.

- Chilled Iron Calender Rolls
- Screens and Screen Plates
- Stuff, Suction and Fan Pumps
- Patent Top and Double Edged Slitters
- Additions and Changes made to Old Paper Machines, Greatly Increasing Speed and Capacity.

CORRESPONDENCE SOLICITED.

For illustration of our machinery, we refer to the plants of the Fletcher Paper Co. pages 122 to 129 and the Kalamazoo Paper Co. pages 138 to 147 of this book.

UNION
SCREEN PLATE COMPANY

FITCHBURG, MASS., U. S. A.
LENNOXVILLE, P. Q., CANADA

Sole Manufacturers of the

WITHAM SCREEN PLATE FASTENER
PATENTED

THE UNION "PHOSPHO TEMPER" BRONZE
(BEST PHOSPHORIZED CAST AND TEMPERED METAL)
SCREEN PLATES

ROLLED BRASS SCREEN PLATES UNION BRONZE SUCTION PLATES
"UNION" BRONZE SCREWS FOR SCREEN PLATES

IMMEDIATE DELIVERY OF THE LARGEST ORDERS
OLD PLATES RECLOSED AND RECUT TO ACCURATE GAUGE SATISFACTION GUARANTEED

Plates installed in the following Paper and Pulp Mills shown on the foregoing pages of this book

WALL PAPER MFRS., Ltd., Greenhithe, Kent, England, 8-41
SPANISH RIVER P. & P. CO., Ltd., Espanola, Ontario, Canada, 42-55
ROANOKE RAPIDS PAPER MFG. CO., Roanoke Rapids, N.C., 98-107
MUNISING PAPER CO., Ltd., Munising, Michigan, 72-85
FLETCHER PAPER CO., Alpena, Michigan, 122-129
J. & J. ROGERS CO., Ausable Forks, N.Y., U.S.A., 130-137
KALAMAZOO PAPER CO., Kalamazoo, Michigan, 138-147.

The Paper Making Machinery

MANUFACTURED BY

The J. H. Horne & Sons Co.

LAWRENCE, MASS.

Is installed in every country, where the art of paper making has been perfected.

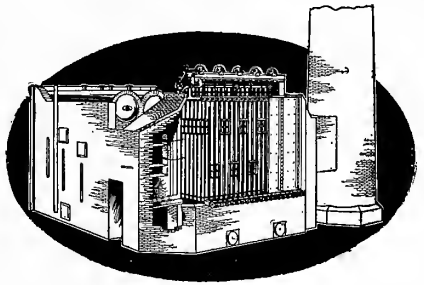
Fourdrinier and Cylinder Paper Machines,
Continuous Paper Cutters, The Horne Jordan,
The Horne Engine, The Horne Plate,
Iron and Wood Tube Beating and Washing Engines,
General Paper Mill Machinery.

IN THIS BOOK THE INSTALLATIONS OF MACHINERY SHOWN ON PAGES 64, 85, 107, 129, WERE BY

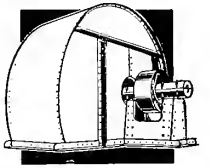
THE J. H. HORNE & SONS CO.

LAWRENCE, MASS.

Green Apparatus for Paper Mills

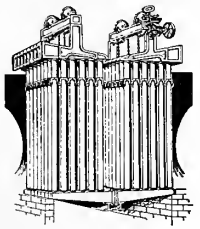


The Green Fuel Economizer is used in many of the largest paper mills to recover waste heat in the chimney flue gases. When employed to heat water for boiler feeding only, the economizer returns its cost in a short time, but when water from the economizer is employed for other purposes, as for washing and in the beater engines, the coal saving may be much greater. The installation of an economizer increases the effective boiler capacity in the same ratio that it saves coal, and the large volume of hot water stored in the economizer is valuable in meeting sudden demands for hot water or steam.

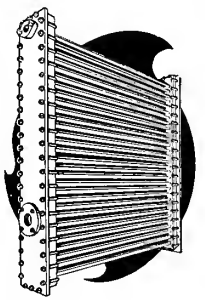


Green Fans, Blowers and Exhausters, as applied to the production of mechanical draft for boiler furnaces, make it possible to burn profitably lower grades of coal or waste products. Green fans are also used in paper mill heating and drying outfits, and for removing vapor from machine rooms. We have designed special equipments for the drying of coated papers, wall papers, etc., for several of the largest mills in this country. The arrangements which we have devised have resulted in a large increase in output in each case.

Green Steam Air Heater Coils for use in hot-blast heater and drying outfits possess the advantage that either live or exhaust steam, or hot or cold water can be used in them, since the circulation is positive and continuous, and these coils are not subject to air-binding or water hammer. They are, further, so constructed, that any tube of any coil can be inspected, cleaned or removed without dismantling.



The Green Waste Heater is a device similar to the economizer and utilizes waste heat from boiler or other furnaces to heat air for heating or drying purposes. The air can be heated to any temperature required and, as waste heat is used, the saving in fuel is obvious.



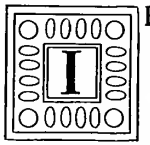
Submit any problems of heating, drying or recovery of waste heat and we shall be pleased to make specific suggestions.
Specialized pamphlets on any of the above subjects upon request.

THE GREEN FUEL ECONOMIZER COMPANY, Matteawan, N. Y.

NEW YORK CITY BOSTON CHICAGO ATLANTA SAN FRANCISCO LOS ANGELES
SEATTLE SALT LAKE CITY MONTREAL

REDUCE YOUR FREIGHT BILLS

By Shipping your Pulp 55 to 60 per cent. Wood Air Dry



IF you ship 50 tons of pulp as it comes from the wet machines at 40 per cent. wood air dry, you pay freight on 250,000 lbs. If by pressing, you reduce it to 55 per cent. wood air dry, the shipping weight will be 181,000 lbs., and you save the freight on 69,000 lbs. of water, or 20,700,000 lbs. per year of 300 working days, or 862 car loads of 24,000 lbs. per car per year. If you reduce it to 60 per cent. wood air dry the shipping weight will be 166,000 lbs., and you save the freight on 84,000 lbs. of water pressed out, or 25,200,000 lbs. per year, or 1050 car loads of 24,000 lbs. per car per year, and have reduced the bulk more than one half. By slacking off the pressure on your wet machine rolls you can run the pulp at from 33 to 35 per cent. wood air dry and save almost enough on your felts to pay for the pressing. Think it over and write us.

WE GUARANTEE RESULTS. ADDRESS

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Boomer & Boschert Press Co., Ltd.
No. 315 West Water Street,
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Electric drive is being installed in some of the foremost pulp and paper mills in America.

The use of electric drive in paper and pulp mills is constantly increasing, because present conditions make it necessary to secure the best product in the least time at the least expense.

General Electric Co. Motors are designed and built with an especial aim to secure long service and reliable operation even under the most difficult conditions. The reputation of General Electric Co. apparatus has been established through years of successful operation in every class of power work.

Munising Paper Co., Munising, Mich.
Roanoke Rapids Paper Mfg. Co.
Roanoke Rapids, N. C.
Quincy Electric Light & Power Co.
Quincy, Mass.
M. J. Whittall, Worcester, Mass.
J. & J. Rogers Co., Ausable Forks, N.Y.

The above plants, which are described in this book utilize electric drive throughout with General Electric Motors.

General Electric Company

Principal Office, SCHENECTADY, N. Y.

New York, 30 Church Street
Boston, 84 State Street
Phila., Witherspoon Building
Cincinnati, Perin Building
Chicago, Monadnock Building
San Francisco, Union Trust Bldg.
Atlanta, Empire Building
Denver, Kitteredge Building

Foreign Departments
Schenectady, N. Y.
and 30 Church St., N. Y.
84 Cannon St., London, E. C.
Canadian G. E. Co., Toronto, Ont.

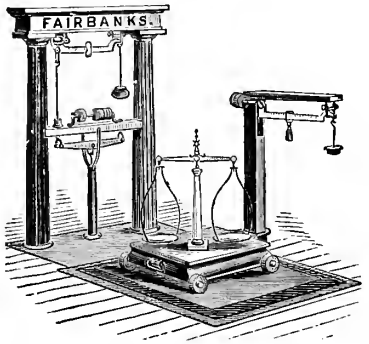
2060

THE FAIRBANKS CO.

FAIRBANKS STANDARD

SCALES

All Types and Capacities For Any Service



Scales specially adapted for
PULP and PAPER MILLS.

Complete catalog on application

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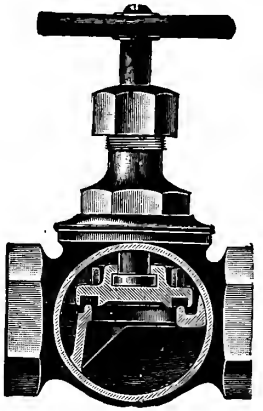
FAIRBANKS Renewable
DISC VALVE



has a reputation solid as the rock of Gibraltar.

Particular people specify and use these Valves where the best results are desired.

The renewable disc is secured to the spindle without nuts, screws or pins which are liable to become detached when in use.

ASK FOR THE FAIRBANKS VALVES

VALVES PIPE FITTINGS

The Canadian Fairbanks Co., Limited

MONTREAL

St. John, N. B. Toronto Winnipeg Calgary Vancouver

Holyoke Steam Boiler Works, Inc.

HOLYOKE, MASS.

Manufacturers of Rotary Bleach Boilers, Steam Boilers Penstocks, Smoke Flues, Tanks, Etc.

Shipment of Four Rotary Bleach Boilers for Wall Paper Manufacturers, Limited, Greenhithe, England.

PAPER MANUFACTURERS USING OUR ROTARY BLEACH BOILER.

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Toronto Paper Mfg. Co.....Cornwall, Ontario
Crane & Co.....Dalton, Mass.
King Paper Co. .....Kalamazoo, Mich.
Collins Mfg. Co..... North Wilbraham, Mass.
J. Spaulding & Sons Co., North Rochester, N.H.
Monadnock Mills.....Bennington, N. H.
Millers Falls Paper Co. .... Millers Falls, Mass.
Kalamazoo Paper Co .....Kalamazoo, Mich.
Companie General de Fosforos, Buenos Ayres, Argentine Republic
Northern Mills Co.....St. Jerome, Quebec
Ashuelot Paper Co..... .... Hinsdale, N. H.
Kinleith Paper Co., Ltd., St. Catherines, Ontario
Eastern Mfg. Co. .....So. Brewer, Maine
Deerfield Lumber Co.....Wilmington, Vt.
East Hartford Mfg. Co.....Burnside, Conn.
Southworth Paper Co..... Mittineague, Mass.

L. L. Brown Paper Co. ..... Adams. Mass.
Crocker-McElwain Co.....Holyoke, Mass.
Wall Paper Mfgrs , Ltd.....London. Eng.
Holden Paper Co. ..... Newburgh, N. Y.
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Wm. Robertson.....Putney, Vt.
Wm. A. Cole Paper Co..... Putney, Vt.
F. W. Bird & Son .....East Walpole, Mass.
Hollingsworth & Vose ....East Walpole, Mass.
Newton Paper Co. .....Holyoke, Mass.
Oakland Paper Co., Div..... Manchester, Conn.
Tileston & Hollingsworth....Hyde Park, Mass.
Parsons Paper Co..... Holyoke, Mass.
Chapin & Gould..... Russell, Mass.
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Norman Paper Co., Div.....Holyoke, Mass.
Riverside Paper Co.. Div. .....Holyoke, Mass.

Linden Paper Co., Div. ..... Holyoke. Mass.
Niagara Paper Mills ..... Niagara Falls, N. Y.
Syms & Dudley ..... Watervliet, Mich.
Whiting Paper Co.....Holyoke, Mass.
McEwan Bros.....Whippany, N. J.
Mittineague Paper Co..... Mittineague, Mass.
Carew Mfg. Co.....So. Hadley Falls, Mass.
Chemical Paper Co.....Holyoke, Mass.
Albion Paper Co., Div.....Holyoke, Mass.
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Geo. R. Dickinson Paper Co. Div. Holyoke, Mass.
Geo. C. Gill Paper Co. Div.....Holyoke, Mass.
Holyoke Paper Co. Div. .....Holyoke, Mass.
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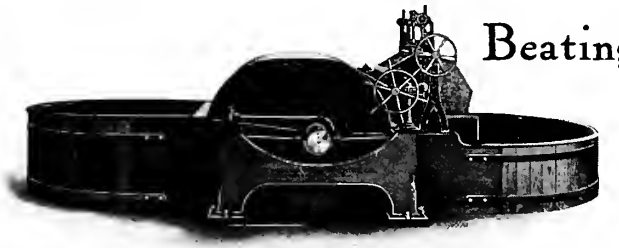
THE NOBLE & WOOD MACHINE CO.

HOOSICK FALLS, N. Y., U. S. A.



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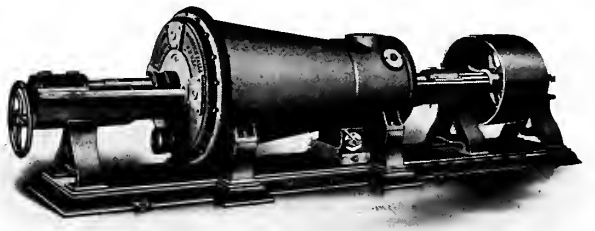
Beating, Washing and Mixing Engines

Wood or Iron Tubs. One-Piece Housings.
Quick Washouts. Large or Small Diam. Rolls.
Circular Bottom.



Five Sizes of Jordans

10, 24, 30, 40 and 60 tons capacity.

Belt or Motor drive, direct connected.
Various styles of filling to meet all mill conditions.

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VARIABLE SPEED FRICTION DRIVES
JORDAN FILLING
ROLL BARS BED PLATES

PATENT DIGESTERS for reducing old papers and broken papers to "half stock."

Installations under J. H. WALLACE & CO.

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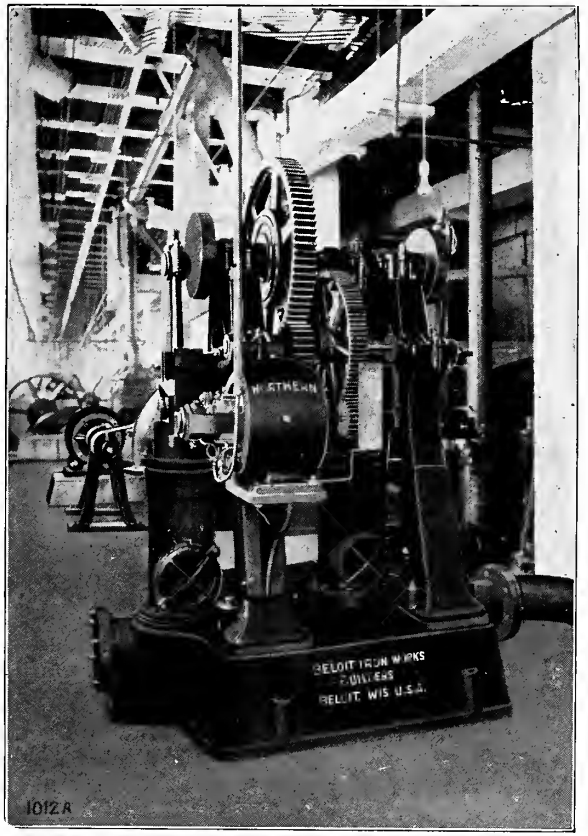
- Georgia Mfg. & Public Service Co., Marietta, Ga., U. S. A.
- Wall Paper Mfrs. Ltd., Anaglypta Branch, Preston, Lancashire, England.



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Beloit Iron Works

BUILDERS OF

Paper Mill Machinery

EXCLUSIVELY.

Our News Machines have made the fastest speed in the world.

Our Board Machines the greatest production in the world.

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Beloit, Wis., U. S. A.

Garland Chip Conveyor at Mill of Fletcher Paper Co.
Alpena, Mich.

We are Conveying and Wood Machinery Specialists

WRITE FOR CATALOGUE No. 40

The M. Garland Co.

Bay City, Mich., U. S. A.

Ingress Abbey Mills, Wall Paper Manufacturers, Ltd., Greenhithe Kent, England.
Equipped with Fenestra Sash.

Wrought Steel Detroit Fenestra Sashes

Adapted for use in substantial construction of

**Warehouses, Factories,
Car Shops, Power Stations,
Paper and Pulp Mills, etc., etc.**

Costs much less than other metal sash, is more sightly and better for purposes mentioned.

It is a substantial substitute for wood. It replaces it at slight expense.

Made from Special Rolled Section

The FENESTRA joint is so constructed that the amount of metal cut out at the joint is reduced to the minimum, therefore strength is a feature.

For further information address
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Detroit Steel Products Company.

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Fourdrinier Wires and Cylinder Wires.

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Perfection Bronze Valves and Castings for Sulphite Mills.

"Y" Valves all sizes, in Bronze and Steam Metal.

Extra Heavy Fittings and Valves for Steam.

Boiler Blow-off Valves.

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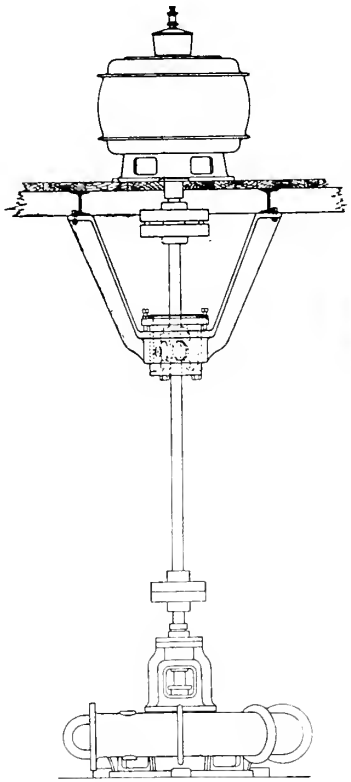

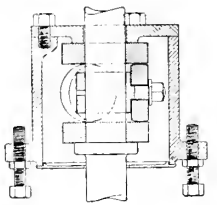

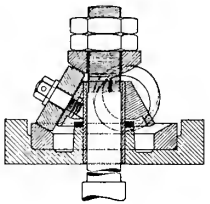

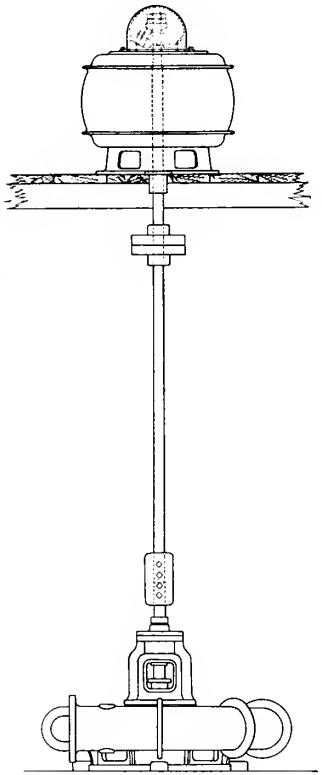

WE show two applications of Planet Bearings to motor driven vertical high-speed centrifugal pumps, the smaller cuts in each case being detailed views of bearings included in general arrangement drawings.

THRUST BEARINGS DESIGNED TO MEET ALL CONDITIONS

More Steam with Less Fuel

A Steady Draft in all Weather Conditions

Fuel Economizers and Mechanical Draft ∴

Sturtevant

Fuel Economizers

Absorb heat from escaping hot gases and use this to heat feed water for the boiler. We prove this means to you 10% to 20% more steam without increase fuel cost. This system installed in Power House at Lyons, New York. Pages 116-122 this book.

Sturtevant

Mechanical Draft

Increases the draft through a chimney already standing, or allows you to dispense with the stack altogether. Weather conditions do not affect this draft, and it can be regulated to suit varying demands on a system. The Spanish River Pulp and Paper Co., pages 42-56 this book have Sturtevant Mechanical Draft installed.

WE ARE THE LARGEST MANUFACTURERS OF BLOWERS AND EXHAUSTERS.

Offices in Principal Cities.

B. F. STURTEVANT COMPANY,

General Office and Works,
Hyde Park, Mass.

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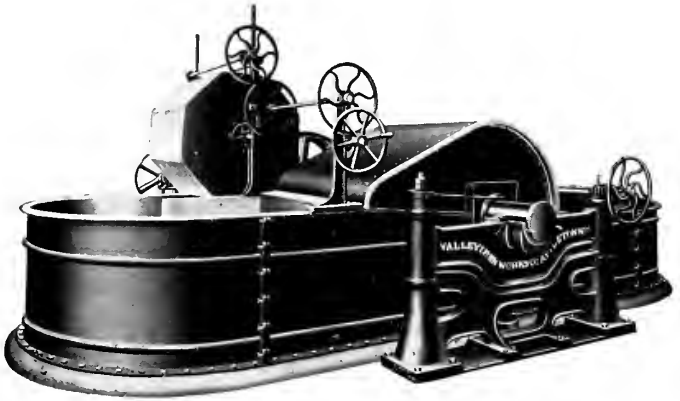

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Engineers, Founders and Machinists

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Paper, Pulp and Sulphite Mill Machinery

The patented features, found solely in OUR Beating Engines, make them the most

Rigid and Best Turning Engines

for all classes of stock

Appleton, Wisconsin, U. S. A.

A. Kieckhefer Elevator Co.

MILWAUKEE, WIS.

Plunger Elevators,
Electric Elevators,
Belted Elevators.

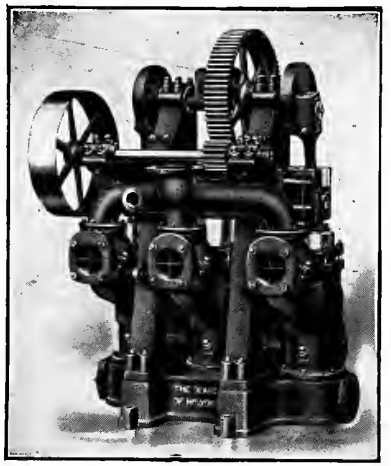
SOAK TANK LIFTS.

We make a specialty of Elevator equipments for Paper Mills.

"J. R. Driscoll, of Springfield, Mass., has taken this space to remind the trade that he is the pioneer in the use of concrete in floors, chests, drainers, beating engines, bleaching apparatus and other paper mill uses, and can show samples of work done for the past 25 years, and still in good operating condition."

All work guaranteed for 25 years if done entirely under my own supervision and direction.

THE DEANE OF HOLYOKE



POWER PUMPS

FOR PAPER AND PULP MILLS

SINGLE—DUPLEX—TRIPLEX

STUFF PUMPS
DIRECT WATER WAYS
EVERY PART ACCESSIBLE

SUCTION BOX PUMPS
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RIGID CONSTRUCTION

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WORKS: HOLYOKE, MASS.

THE

Cleveland Crane & Engineering Co.

WICKLIFFE, OHIO

We manufacture Cranes of every description, both Electric and Hand Power, and have installed cranes in the following plants illustrated in this book:

Wall Paper Mfrs., Ltd., Pages 8 to 41.
Munising Paper Co., Ltd., Pages 72 to 85.
Kalamazoo Paper Co., Pages 138 to 147.

We would be pleased to have your inquiries. Catalog will be sent upon request.

UNION MACHINE CO.

Fitchburg, Mass., U. S. A.

Paper Mill Machinery

We recently sold the Roanoke Rapids Paper Mfg. Co. one of our fast running, high speed, modern, Fourdrinier paper machines, of heavy design, from our latest and most up-to-date patterns. A full description of their plant and equipment will be found on pages 98 to 107.

We equipped the Wall Paper Manufacturers Co., Ltd., Greenhithe, Kent, England, with "WYMAN" JACKET STRETCHERS. See description of their plant on pages 8 to 41.

The Kalamazoo Paper Co., Kalamazoo, Mich., are users of our "UNION" BLEACH HOISTS. Their mill is described on pages 138 to 147.

The above machinery was sold through the agency of Joseph H. Wallace.

OVER 30 "UNION" BLEACH HOISTS ARE IN OPERATION IN THE STATE OF MICHIGAN.

Jordan Engines
Cylinder Moulds
Kollergangs
Wood Rolls
Pumps
Rolls Re-ground

WILLIAMS-GRAY CO.

Western Agents CHICAGO, ILL.

.... The ....

Exeter Machine Works

PITTSTON, PENNSYLVANIA

Manufacturers of

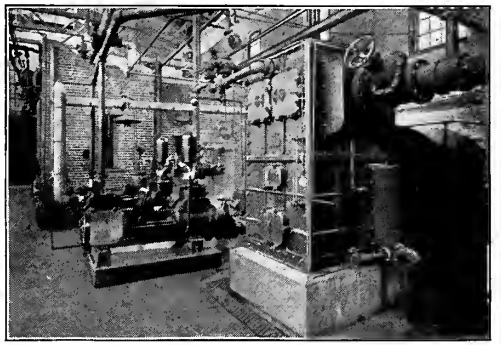
Coal and Ash Handling Machinery

Elevators and Conveyors

for handling pulp and paper.

Bronze and Brass Castings where great strength and acid resisting qualities are required.

Stone's Navy White Bronze which is the best anti-friction metal in the world.



MORE HOT WATER

from the same amount of exhaust steam can be obtained from a Cochrane Open Feed-Water Heater than from any closed heater arrangement, because the Cochrane Heater conserves and utilizes the exhaust steam which is condensed in heating the water. At the same time, the Cochrane Heater acts as a hot well or return tank for steam condensed in the heating or drying rolls, paper machines, etc., in many cases saving the cost of traps or receiver pumps.

Heating the boiler feed not only saves coal, protects the boilers from temperature strains and increases the boiler steaming capacity, but the Cochrane Heater will also supply hot water for the beater engines, for washing pulp, etc.

If the raw water contains permanent hardness, we shall be pleased to explain our Hot Process System, by means of which the water can be purified at the same time that it is being heated. This will save you a big bill for boiler cleaning and repair bills, as well as render the water more suitable for manufacturing purposes. Our process saves the cost of lime and of chemical analyses.

If you wish to use exhaust steam for any purpose whatever, it should be purified of oil. This can be done most effectively by the use of a Cochrane Oil Separator.

Give us some information about your plant and we shall be pleased to submit layouts and an estimate of the possible savings.

HARRISON SAFETY BOILER WORKS

3178 N. 17TH STREET PHILADELPHIA, PA.

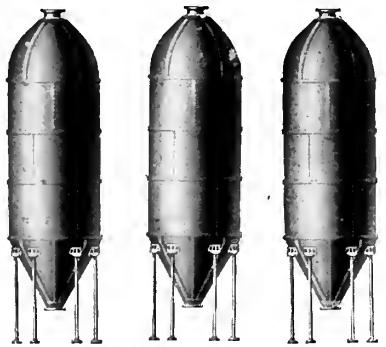
DIGESTERS

SULPHITE
SODA
ROTARY

Also BOILERS, TANKS, Etc.

MANITOWOC BOILER
WORKS COMPANY

MANITOWOC, WISCONSIN



Cheney Bigelow Wire Works

MANUFACTURERS OF

Fourdrinier Wires
Cylinder Molds
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OFFICE RAILINGS
ELEVATOR ENCLOSURES
WIRE SIGNS

Write for Catalogue

Springfield, Mass.

Ryther & Pringle Co.

CARTHAGE, N. Y., U. S. A.

Wood-Room Engineers

DESIGNERS AND BUILDERS OF

COMPLETE MILLS FOR PREPARING WOOD FOR PULP AND PAPER MILLS, TO MEET ALL CONDITIONS AND FOR ANY CAPACITY.

CONVEYOR SYSTEMS

FOR YARD STORAGE AND ALL MILL REQUIREMENTS

Slashers, Swing and Jump Saws, Splitters, Chip Screens and all kinds Wood Handling and Preparing Machinery.

PLANS. ESTIMATES.

The cut on page 51 shows one of our Multiple Saw Slashers in actual operation.

CARTHAGE MACHINE CO.

Carthage, N. Y., U. S. A.

GRINDERS BARKERS CHIPPERS

WET MACHINES

CRUSHERS PUMPS

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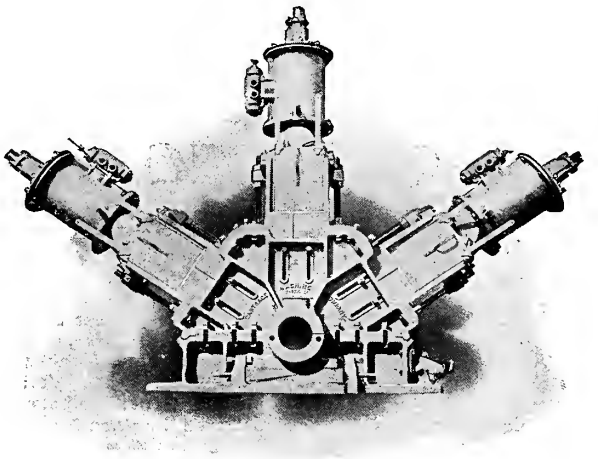
CHIP SCREENS



THE "ABC" FAN SYSTEM OF HEATING

SPECIALLY ADAPTED TO

PAPER and PULP MILLS

The proper amount of heat to keep moisture in suspension together with positive circulation of air for carrying off the moisture is provided, and the prevention of fog in Machine rooms is successfully accomplished by the "ABC" FAN SYSTEM.

"ABC" APPARATUS IS INSTALLED IN THE HEREIN DESCRIBED MILLS OF

WALL PAPER MANUFACTURERS, Ltd. . . .	England
MUNISING PAPER COMPANY	Munising, Mich.
FLETCHER PAPER COMPANY	Alpena, Mich.
KALAMAZOO PAPER COMPANY . .	Kalamazoo, Mich.

"ABC" APPARATUS IS ALSO IN SUCCESSFUL OPERATION IN MANY OTHER PROMINENT MILLS INCLUDING

INTERNATIONAL PAPER CO. . . .	Various Locations.
CHAMPION COATED PAPER CO. . . .	Hamilton, Ohio.
ANGLO-NEWFOUNDLAND DEVELOPMENT CO. .	Grand Falls, N. F.

SIROCCO

AMERICAN BLOWER COMPANY

PRINCIPAL OFFICES: DETROIT, MICH.
WORKS: DETROIT, MICH. AND TROY, N. Y.

Manufacturers "SIROCCO" CENTRIFUGAL FANS AND BLOWERS

"ABC" Systems of Heating, Ventilating, and Mechanical Draft. Disc Ventilating Fans and Steam Traps, Vertical Enclosed Self-Oiling Steam Engines for Generator Sets and Centrifugal Pumps, and Variable Speed Engines for Paper Machines.

SECTIONAL OR COMPLETE CATALOGS UPON REQUEST

Norwood Engineering Co.

FLORENCE, MASS.

Paper Mill Equipments

INSTALLATIONS IN

Wall Paper Manufacturers, Ltd., Greenhithe, Kent, Eng.
(See pages 8 to 41)

Ashuelot Paper Co., Hinsdale, N. H., U. S. A.
(See pages 62 to 65)

Kalamazoo Paper Co., Kalamazoo, Mich., U. S. A.
(See pages 138 to 147)

Structural Steel

OF EVERY DESCRIPTION FOR

Mill Buildings Pulp Mills
Hydro-Electric Plants
Power Houses

Chesapeake Iron Works

BALTIMORE, MD.

CHARLOTTE, N. C. WASHINGTON, D. C.

The Steel Work used in the construction of Pulp Mills for Roanoke Rapids Paper Manufacturing Co., and Hydro-Electric Plant for Roanoke Rapids Power Co., Roanoke Rapids, N. C., designed by Messrs. Jos. H. Wallace & Co., was supplied by us.

We respectfully refer you to these Engineers.

Alphons Custodis Chimney Construction Co.

BENNETT BUILDING

NEW YORK

Expert Designers and Builders of

Radial Brick Chimneys

All Sizes—For all Purposes
For Boilers, Furnaces
Smelters, etc.

Builders of the **Tallest** and **Largest Chimney** in the **World.** 506 feet high, 50 feet Diameter, at Great Falls, Montana.

BRANCHES

Chicago	**St. Louis**	**Salt Lake City**
Philadelphia	**Detroit**	**Denver**
Boston	**Indianapolis**	**Great Falls, Mont.**
Atlanta	**Cincinnati**	**Pittsburg, Kans.**
Cleveland	**Montreal**	**San Juan, P. Rico**

APPENDIX

THE mills described in this volume were selected as typical examples, and the following samples of paper were chosen to show the character of the output to which each plant is particularly adapted.

The nature of the products of the Uncas Plant of the American Strawboard Co., the Flintkote Mfg. Co., and of the Spanish River Pulp and Paper Co. does not permit of their being included in this collection.

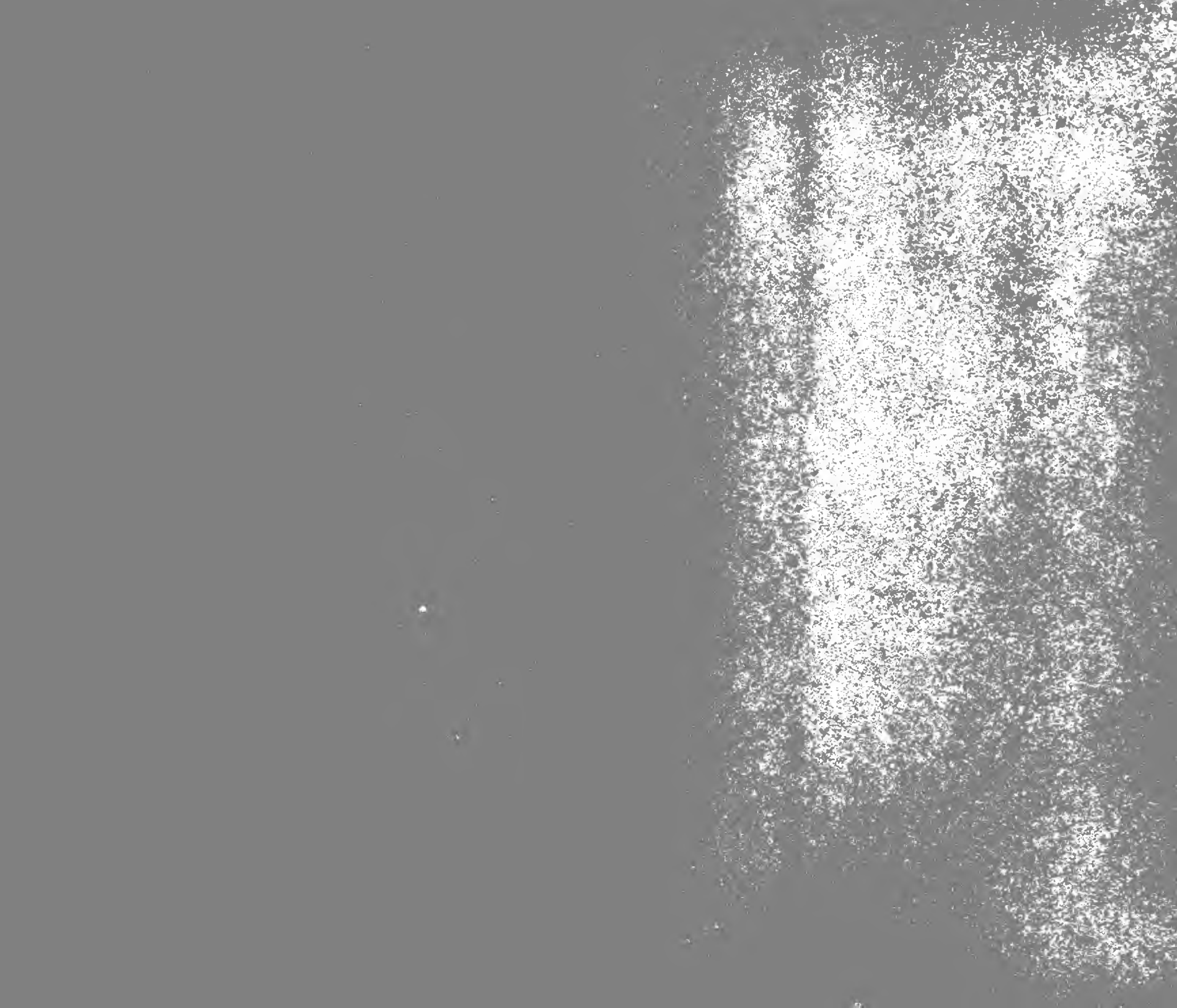
The Ingress Abbey Mills, of the Wall Paper Manufacturers, Ltd., have not been in operation long enough to produce the complete line, and some of the papers shown were made by other mills of this company and included, because they illustrate the class of work for which the plant at Greenhithe was designed.

The Six Samples following

were manufactured by the

WALL PAPER MANUFACTURERS, Ltd.

ENGLAND



The Three Samples following

were manufactured by the

ASHUELOT PAPER COMPANY

HINSDALE, N. H.

Manufacturers of High-grade

COPYING, PATTERN, JUTE AND ROPE

TISSUES

Made in weights, 24 x 36—5 to 20 lb.
Widest trimmed sheet 81 inches

The Three Samples following

are manufactured by the

MUNISING PAPER CO., Ltd.
MUNISING, MICH.

The Three Samples following

were manufactured by the

MUNISING PAPER CO., Ltd.
MUNISING, MICH.

The Three Samples following

were manufactured by the

B. D. RISING PAPER COMPANY

HOUSATONIC, MASS.

The Three Samples following

were manufactured by the

FLETCHER PAPER COMPANY

SULPHITE, EXPRESS AND MANILA

PAPERS

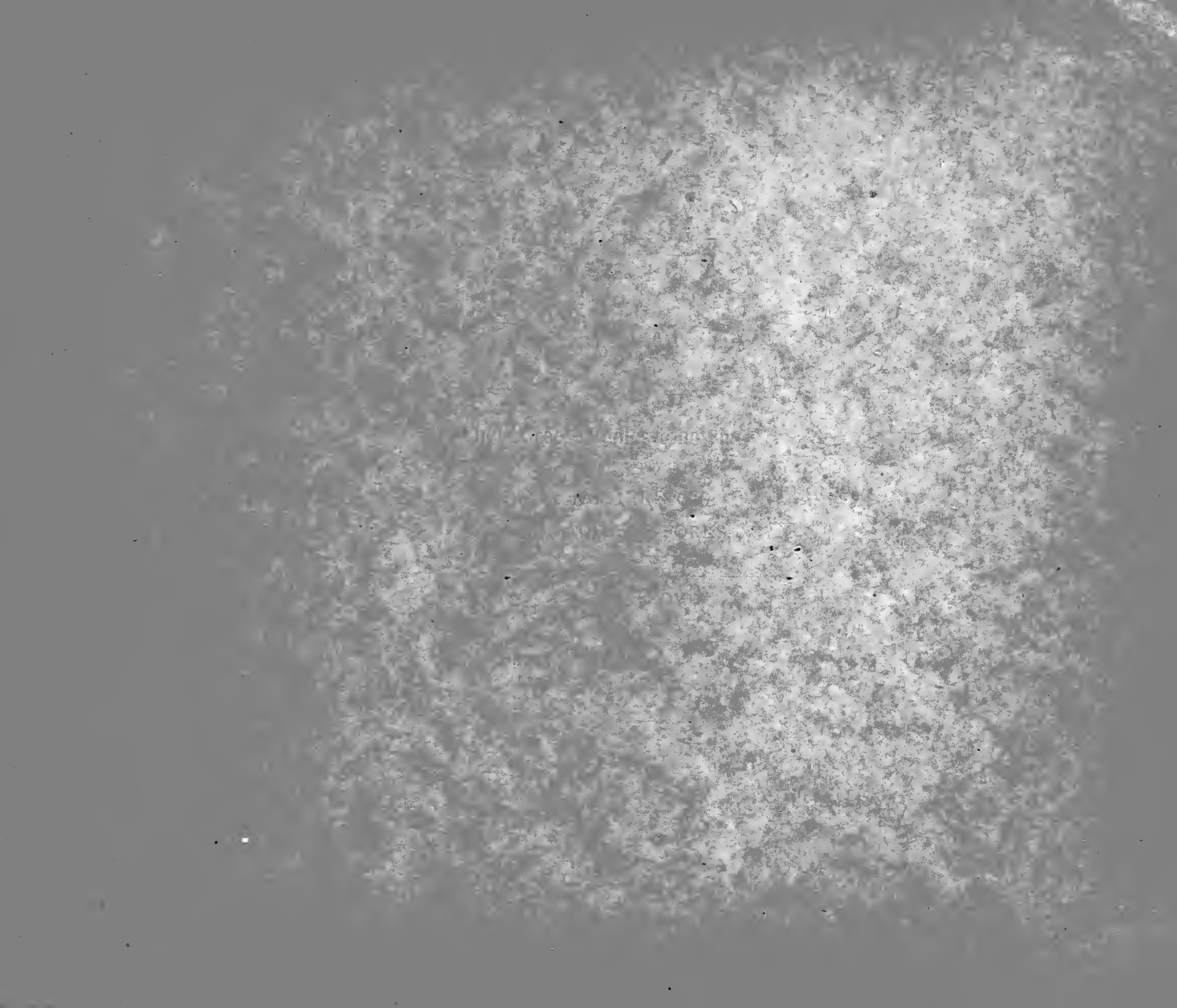
FRANK W. FLETCHER, President
ALLAN M. FLETCHER, Secretary
WINTHROP F. VICTOR, Treasurer

ALPENA, MICH.

The Fletcher Paper Company was organized in 1898, the members of it having been in business in Alpena for the previous thirty years, and operating the first Mitscherlich sulphite mill in the country, built here in 1886.

The Paper Mill proper consists of two Fourdrinier machines, trimming 190″ and making dry finish and water finish fibres and colored papers. Also one three-cylinder machine trimming about 62″, on which we run all weights from 50 to 250 pounds.

We manufacture all our own Sulphite and Groundwood, buying no material at all. Our mills are thoroughly modern and up-to-date, and of practically fireproof construction.



The Three Samples following

were manufactured by the

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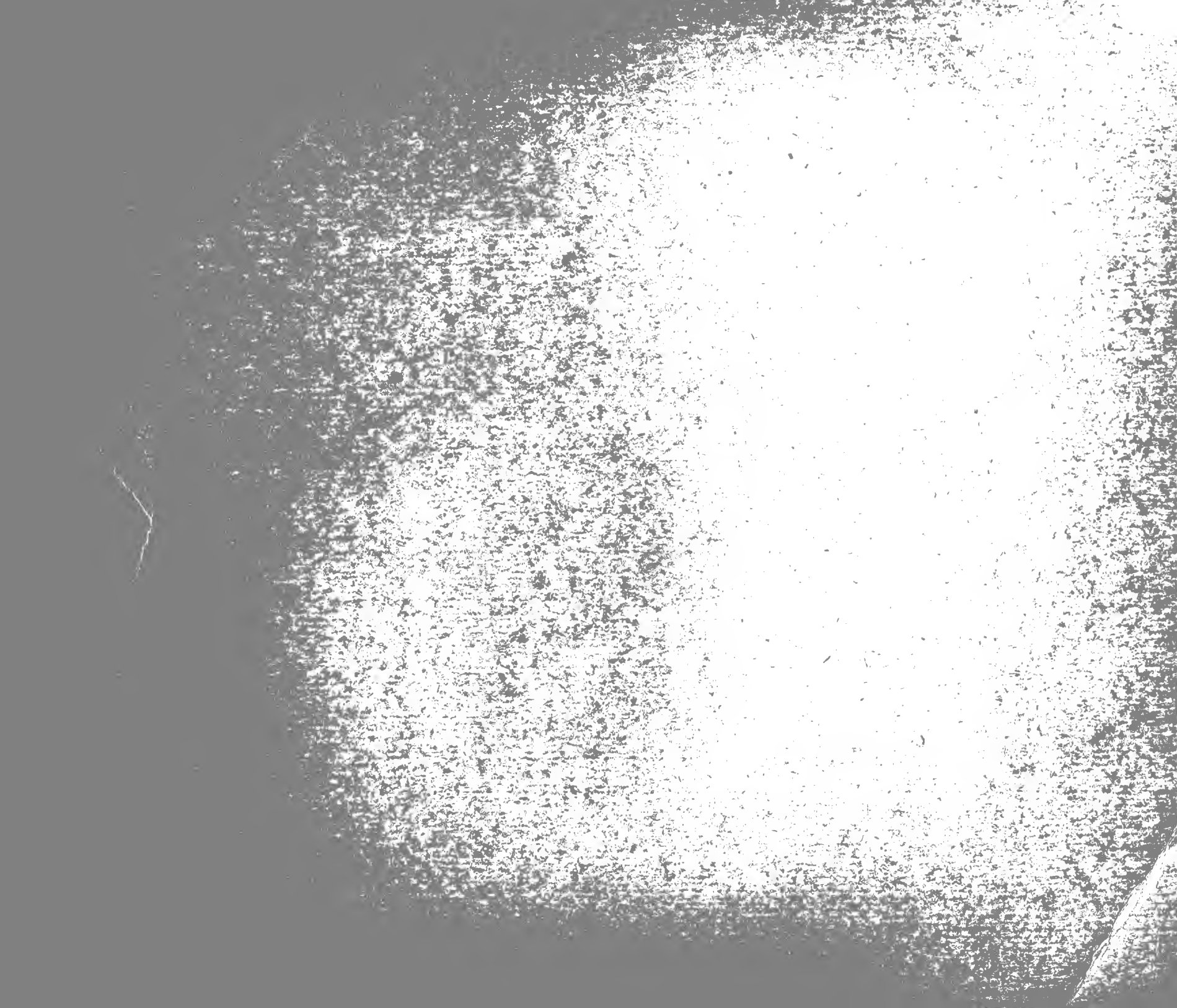

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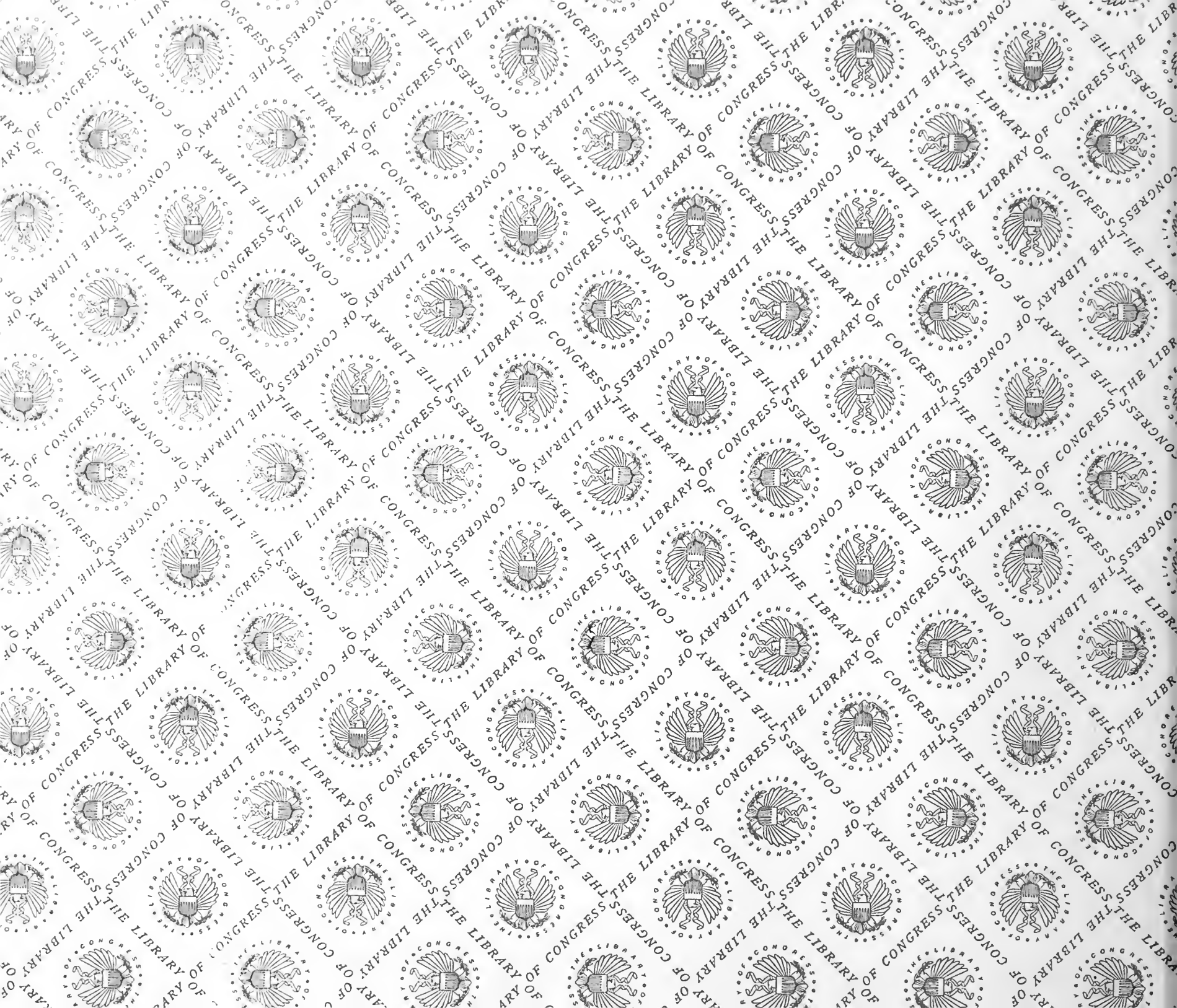
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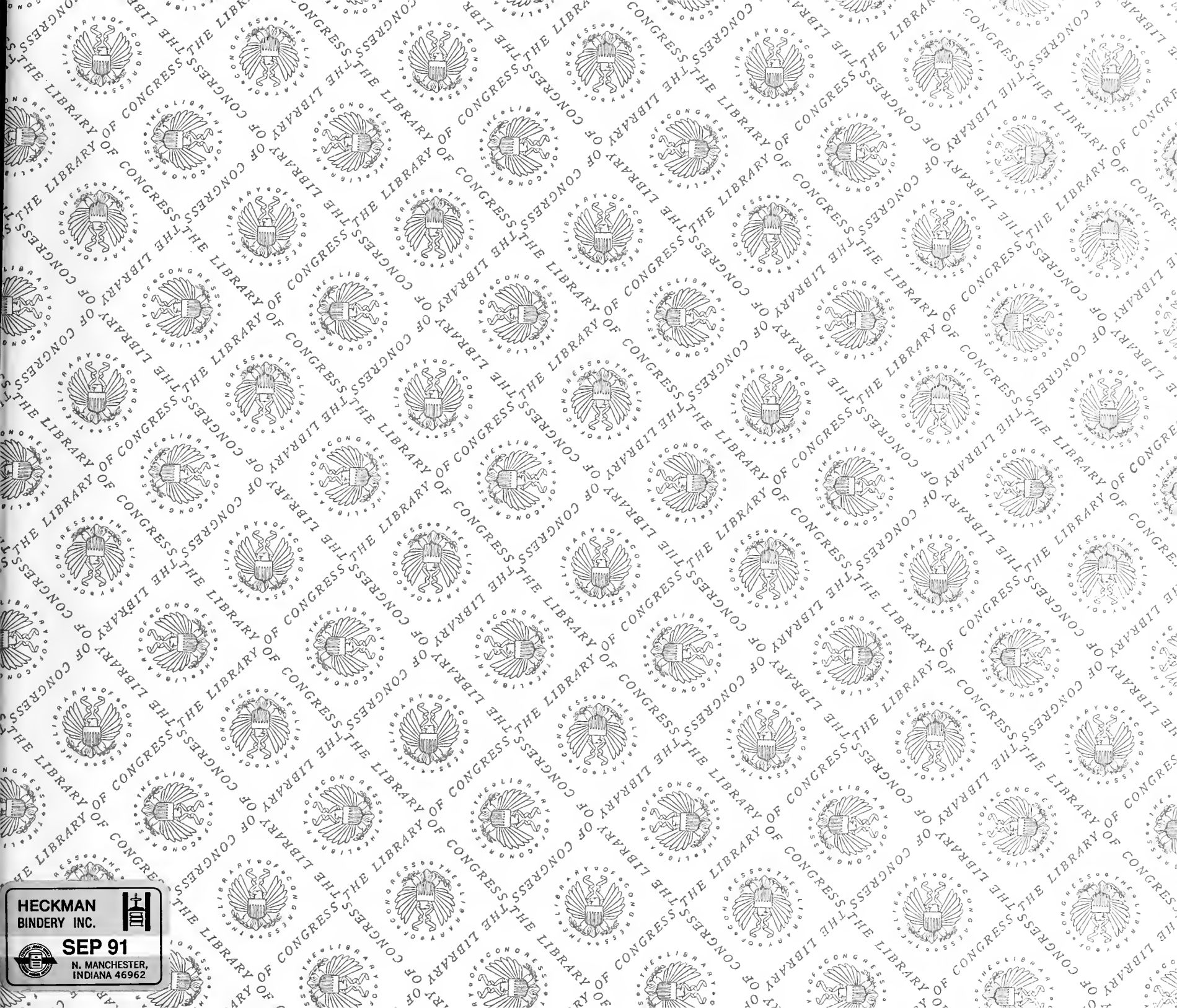

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